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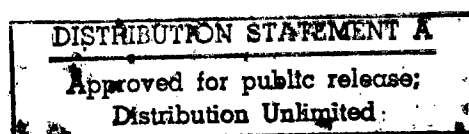
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A Good Thing It Hasn't Broken. So Far...

907M0320a Moscow *RABOCHAYA TRIBUNA*
in Russian No 216, 21 Sep 90 pp 2-3

[Article by U. Bogdalov, Kazan]

[Text] The world is becoming increasingly insecure and dangerous, we have no one to blame but ourselves. We have treated nature like a city surrendered for pillage. The ardent epic poem honoring edifices of communism great and small, like the song of the capercaillie, has switched off elementary discretion. Enraptured with illusions about the new man supposedly given birth by our nation, we have been closing our eyes to the actual worker standing at the control panels of enormously complicated chemical plants, turning out defective machine components and laying unreliable pipelines...

Has the Risk Been Planned?

The reader watches television and is not to be shocked. It would make you cry to see and hear all this....

But we should see it and hear it. Because all of this neglectful past has densely mined the present and future. My own enlightenment has not been epiphanic: after all, I live and work in a mighty industrial region. I have known that in the near future we should expect, and so should get ready for a considerable increase in severe technogenic accidents in the petrochemical industry, and disasters on pipelines and railroads and in municipal services. Dangerously unpredictable situations await us as well due to the actually non-punishable criminally negligent storage of toxic industrial waste. According to conservative calculations, more than 77,000 metric tons of such waste is produced in Kazan alone, and there are absolutely no industrial sites for storage and recycling.

However, let me take a closer look at the chemistry and petrochemistry that was formerly a source of such great pride in my region of Tataria, and has been heedlessly developed: "Orgsintez," producing half of the polyethylene of the nation, "Neftekhim," producing one third of the artificial rubber, and "Tasma," producing a good fraction of Soviet photographic and movie film.

They are now the focus of human anxiety. There are many reasons for this. A year ago, a gas fractionating installation exploded at the Minnibayevo Gas Refinery. People were killed. The commission did not expose violations in service. I reported at that time that the equipment had been operating for 25 years, even though much smaller units are scrapped in the United States after 8-10 years.

Immediately after publication, I received several replies from workers at petrochemical enterprises of the region. They confirmed that this is no exception to the rule. A lot of equipment at this same "Orgsintez" is now working on its second life. This was a shock to specialists invited from West Germany two years ago to take part in reconstruction of some facilities. And to this day

machines dating from World War II can be seen here in Kazan at the Kirov Synthetic Rubber Plant.

Last year, I had occasion to write reports about a big fire at a flagship of the industry, "Nizhnekamskneftekhim," where an enormous explosion completely destroyed the isobutane pumping department. At the cost of two firemen's lives, the fire was stopped while approaching the spherical storage tanks, whose explosion would have been totally unpredictable for nearby city apartments.

The conclusion of the commission was unanimous: the shaft of a heavy-duty pump had broken. First of all, it had been made of brittle metal in bygone days, being a so-called technologically admissible substitution for the necessary grade. And secondly, it had been on its last leg for a long time.

There are multitudes of such used up components in crucial and not so crucial equipment throughout the nation. Their continued service will not make them stronger. The technical backwardness of many chemical plants due to using equipment until it is worn out is both economically disadvantageous and lethally dangerous.

But might Tataria be the only region where there is a danger of chemical explosion? Far from it. Over the past 18 years in chemical enterprises of the nation there have been about 150 accidents with severe traumas and frequently loss of life, obliteration of buildings and equipment. In addition, there have been more than 4500 less severe production problems every year.

In publishing these figures, the chairman of Gospromatomnadzor USSR, V. Malyshev states that the risk of large-scale accidents with disastrous consequences is due to the high pace of development of the chemical industry in our nation. I beg to differ. "Chemistry" with its intricate technological lines for producing and processing explosive and toxic products is developing throughout the entire world. But I am sure that we are the only ones for which antiquated equipment is becoming the cause of most accidents. While I am not in possession of data for the entire industry, this is the conclusion suggested by statistics.

With Electria at the Ready

The danger increases year by year. We must continually remember, talk and shout about it! As we must about the concentration of fuels and explosive materials on industrial sites being about 3,000 metric tons per hectare. And this is the equivalent of 30,000 metric tons of TNT, or 10,000 metric tons more than the destructive force of the bomb dropped on Hiroshima.

Life itself confirms these arguments. A powerful blast recently shook Yaroslavl. A facility for producing aromatic hydrocarbons at Novo-Yaroslavsk Oil Refinery flew into the air, taking six human lives. The conclusions of the commission are as yet unknown. The only thing that is certain is that the facility had not long to hold out

before a major overhaul scheduled for 1 September of this year. We should not be surprised!...

Someone should be keeping a very close eye on the equipment now being used in Soviet "chemistry," yet carelessness reigns supreme in that area!

I am reading a commendation relating to the Kazan Production Association "Orgsintez" dated 18 October of last year: "Compressor unit operator S. Kochneva has been awarded a bonus for decisive action in preventing an accident." In the dead of night, some unknown persons entered the engine room of one of the shops and shut down a "Domag" compressor. Not long thereafter, polymerization in the reactors stopped, linked in a complex technological chain that utilizes combustibles and explosive products...

At night, then, on the enormous territory of the association, someone is loitering about, frightening the assayer coming to take her samples.

Now add to this the quality of the specialists who sit at the control panels of the facilities that produce "explosive and toxic materials." Many of these should be closely watched as well. In Kazan, which hosts one of the largest and most famous institutes of chemical technology, I got some information for sober consideration.

High school graduates have been coming in waves to Kazan Institute of Chemical Technology from regions of Transcaucasia and Soviet Middle Asia, where the development of "chemistry" is burgeoning as everyone knows, because it is clear that "a few more" specialists are needed there. Therefore, a strict and elevated quota for enrollment was stipulated, and tests for admission were given by batches and organized at the place of residence.

Naturally, some fine students have entered the university. Department chairman V. Ivanov names a student Orazov from Chimkent as one of his best. But take a look at a transcript of a test with another future engineer, who for the moment is a freshman from Transcaucasia.

"In what units is pressure measured?"

"In electrias..."

"Explain the nature of such phenomena as thunder and lightening."

"Weather does that."

"What is a compass card?"

"I don't play cards..."

This conversation took place in the refrigeration and compressor department last year; comments, as they say, are superfluous...

The higher educational system now apparently wishes there were someone to train and something to train them for. Extension admission centers in Moscow have even

been reduced to half. They say that right now the exams are being given without indulgences. But what are we to do with the semiliterate specialists turned out in such a hurry in former years? They are already at the control panels in the motherland from which, alas, there is a growing stream of departing Russian-speaking engineer, machine operators, dispatchers...

Road to Nowhere

Things are no better on the tracks over which explosive and toxic raw materials and products are shipped to all quarters, and at times across the entire nation.

Last December at Alaty Station in Chuvashia, a tank car containing strong poison began to leak. The most experienced workers in accidents of this kind from another chemical giant—the "Khimprom" Association—were unable to stop the leak. It was decided to take it by a special train concealed by 12 flatcars to the consignment station in Kazan. A good 200 kilometers and six hours of track. To those accompanying this source of poisonous and explosive cloud, hours seemed like eternity. They were faint with fear upon seeing a man with a lit cigaret in the woods along the track...

At that time, a well known railroad man who took part in the lethally dangerous itinerary said:

"Imagine my state. After all, I knew that we were shipping a dangerous tank car over a dangerous railroad. Major overhaul of the track is more than doubly overdue here."

The railway authorities later gave me dozens of reasons for the disorder on the railroad. Each one was more objective than the last. But can there even be any reasons in such a situation? One must sound the alarm! I have only one thing to add: thousands of kilometers of track lying all around the country are in such a state right now...

The aforementioned problems are further exacerbated by unlimited disorder. A certain R. Khusainov, for example, left brake-block heads on the tracks at Yudino station. A train in the classification yard "stumbled" over them, losing the head tank car containing butylene, which went tumbling down a slope. It was only by a miracle that nothing worse happened...

And here is another story. The citizens of a village near Kazan heard the roar of a jet engine from a nearby meadow, followed by the smell of gas. It turned out that the gas had been released into the atmosphere by repairmen working on a gas main passing through here. They had found a hole, and to patch the thick-walled pipe they had to release gas from a section 300 kilometers long under pressure of dozens of atmospheres.

It was a good thing that it didn't break, as had happened near the village of Aldermysh in 1985 in the same kind of situation. At that time, there had been flying glass in houses... This is not to mention the hundreds of cubic meters of costly gas that disappeared into thin air.

Legs of the most famous transcontinental gas lines extend through our region. They can be considered new for the moment. But tomorrow?... Film insulation has been used on a sizeable fraction of the pipes. Its guaranteed service life is 10 years, although the gas line is designed for 30 years. Go figure.

At the same time, film is used world-wide to insulate only about 10 percent of pipelines, and those only for safe products that flow through main lines under the most stringent conditions. Pipes are usually protected by dust-spraying with a tight polymer layer under factory conditions. Where is our guarantee that we will not have a break tomorrow, the day after tomorrow, or even right now in some places?...

With all our business organization, habits and psychology of today we are condemned to the disasters of tomorrow. The mindless "Give!", squeezing everything and a little more out of the machine, scrimping on repairs—this is our way. And if something should happen, we will not be frightened, one of us will be come a hero.

Isn't that why adjusters, repairman and fitters are generally the first candidates for a trip to the collective farm under patronage? Auxiliary service is just that—auxiliary. This is where staff reduction generally begins. The pay is lower than for main production. Spare parts and reserve operations services come last.

Carelessness has become almost a trait of character among us. Just remember how defenseless Chernobyl found us: no special machines, no mechanisms—nothing! A notepad records a significant fact: a chemical research institute in Kazan has been working for a long time on heavy protective suits with self-contained life support systems. But it was not until a month after the reactor exploded that the order was finally received to produce them.

Might the market force us to be more circumspect?

It is time to develop an effective economic mechanisms that stimulates the search for new technologies. If we were to make the ruble rather than administrative-command methods the main regulator of economic relations, it should actively stimulate introduction of a comprehensive precautionary system.

Incidentally, an entrepreneur in the United States who ignores safety requirements pays as much as \$10,000 or serves up to 6 months in prison. A repeat offense entails a fine of up to \$20,000 dollars or a year in prison. That might give you pause for thought. And how else are we going to save ourselves from impending misfortunes?

The only thing I don't understand is: what is stopping us from emulating this experience?...

What Analysis Has Shown

907M0320b Moscow *RABOCHAYA TRIBUNA*
in Russian No 216, 21 Sep 90 p 4

[Article by Yu. Kirinitsyanov, Kazakh SSR]

[Text] As we reported, there was an explosion last week at the nuclear fuel plant in Ust-Kamenogorsk.

How has the city fared in these few days since the accident?

The first impression is that the entire city is taking a shower. Sprinkling machines are rolling over the streets and sidewalks and knocking down yellowed vegetation.

Specialists from the municipal and regional sanitation and epidemiology stations have been visiting working collectives to calm the people down and teach them to withstand the terrible danger, albeit with simple weapons—a pail of water and a rag. K. Isembayev, chief of the sanitation division of the municipal sanitation and epidemiology station, has to make a self-critical admission: "Everything that we are doing is necessary, but it should have been done before."

The fact is that the municipal and regional sanitation doctors have not concerned themselves with hazardous beryllium and indeed have no special equipment. It is only now that they have learned the necessary techniques.

And what have the first analyses shown? About 600 people have been examined, primarily those who took part in cleaning up the accident.

Berylliosis is an insidious disease. It is difficult to distinguish from allergy or congestion of the upper respiratory tract. That is why a control group of 60 people (half of them children) had been organized whose health will be watched by doctors for a year. In addition, all medical centers of the city are being monitored. If people come in more frequently for the "flu," the alarm should be sounded.

"As a doctor and as a citizen of this long-suffering city, I would like to have this dangerous enterprise moved away," says R. Soboleva, chief of the regional health department. "But I am afraid that we won't be able to break the resistance of the nuclear agency authorities."

Alas, she has every reason to be pessimistic. Ust-Kamenogorsk is literally saturated with dangerous enterprises.

Last year, workers in the Shemonaikhinskiy Copper Mine were victims, and this year doctors have had to give aid to eight railroad workers from Zashchita Station, which is downwind from the Ulbinskiy Steel Plant, Ust-Kamenogorsk Lead-Zinc Combine, and the local heat and electric power center. The diagnosis: complex poisoning.

Incidentally, I would have given a different diagnosis: putting up with too much.

I asked S. Targautov, chief of the inspection administration of the State Committee on Conservation of Nature of Kazakh SSR, to comment on the situation in Ust-Kamenogorsk, as the paper had published an interesting detail in our last article: until very recently, committee specialists had not been allowed to cross the threshold of the plant entrance gate. Has anything changed today? Apparently not much.

As of now, we have no word on the nature conservation committee: it is still "working on the questions" and "getting settled" in the republic's Council of Ministers. And only later will it be sanctioned at a session of the Supreme Soviet of the Kazakh SSR. The only document that now regulates relations with the nuclear agency is a protocol on delimitation of functions set forth by an extraordinary commission of the Council of Ministers of the USSR.

In brief, it says that specialists on conservation of nature only monitor the ecology without intervening into technology. It has been left in the hands of agency control of Gospromatomnadzor. The rigor with which this agency monitors itself can be judged from the example of Chernobyl.

"I feel," stressed S. Targautov, "that our committee simply needs a department on radiological control. But all specialists and all control equipment have been usurped by the Ministry of the Nuclear Power Industry. There is not a word in the protocol about how we are to get it."

As We Go to Press

When this material was all ready for publication, I learned that a high beryllium content had been recorded in more than 30 people following the accident at the Ulbinskiy steel plant. The Presidium of the Regional Council of People's Deputies passed a resolution to shut down beryllium production at the Ulbinskiy Steel Plant Association.

Before and After the Accident

917M0002A Moscow *RABOCHAYA TRIBUNA*
in Russian No 227, 5 Oct 90 p 2

[Article by Yu. Kirinitsyanov, Kazakh SSR]

[Text] *B. Barchenko, People's Deputy of the Kazakh SSR and worker at the Ust-Kamenogorsk Lead-Zinc Combine, ponders the lessons of the tragedy that occurred in his native city: an explosion at the nuclear fuel plant (Rabochaya tribuna, 16 Sep and 21 Sep 90).*

I learned about the accident from my daughter. She called from Ust-Kamenogorsk, telling me that the city was in a panic. People were rushing about the streets wearing gas masks and respirators. I calmed her as best I could. I advised her to close her blinds and stay in the

house. You know, I didn't work for 30 years at an unhealthy trade for nothing.

I tried later to call back to Ust-Kamenogorsk again, but got no answer. I couldn't even get the receptionist to the first secretary of the regional committee of the Party. It was only after I called the long-distance office by government telephone that I was connected to the receptionist. The secretary told me that a meeting of the Presidium of the Regional Council was being held. That was all the information there was to be had. As for other telephones, the official version was that fuses had blown in the telephone offices. When they finally started working again, I was called by one of the volunteers who are supporting me in the election campaign. He informed me that the officials, and especially the directors of the plant where the accident had occurred, were not telling the public the real story. That's when I decided to fly to Ust-Kamenogorsk.

The data given to me by the electorate ecologists differed considerably from the official version.

I rushed to the special session of the city council. N. Nosikov, chairman of the city council, allowed me to speak with considerable reluctance. But at that moment, I was given a letter from workers of Vostokmashzavod. And incidentally, my electorate. The people were demanding complete and honest information.

One of the directorate of Ulbinskiy Steel Works had stirred things up. He had appeared on the evening television: there was no need for examining the children in the city, as even the firefighters in the middle of the disaster had come to no harm... As things turned out this was not exactly true.

A meeting of city emergency headquarters was held the next day. A sour note had to be played amidst the chorus of generally calming voices. It was explained that the plant, no matter how dumb it sounds, had no emergency plan. That's right, we learned nothing from Chernobyl. And the "boss" of both accidents was the same Ministry of the Nuclear Power Industry. But the awful thing is not just that the agency is ruining man's physical health. It is morally crippling him. I visited Ulbinskiy Steel Works, and met with the director general, V. Mette. It seems that his optimistic statements had not reassured people, but had only damped their enthusiasm.

We need to take a separate look at civil defense. Its representatives once more showed total helplessness. There was a great delay before the radio report was transmitted, and then only on one station rather than three. After a similar failure during the earthquake, I sent them a deputy inquiry, but got no answer at that time either. Another point. It turns out that most of the protective clothing is located in a village ten kilometers away from the city.

Ultimately, though creakingly, the machine started to turn. Communal services are scrubbing the city, doctors are examining patients. The Presidium of the Regional

Council has finally passed a resolution to close the beryllium plant. A kind of victory, but alas, with a very bitter taste. I foresee a major onslaught on the part of the mighty agency. And it isn't that alone that bothers me. I'm afraid that the attitude toward the nuclear plant will be turned against the completely blameless workers.

The people of the city have found themselves in a danger zone not only because of this accident, but in consequence of the prolonged operation of giants of nonferrous metallurgy, enterprises of the defense industry, within the city limits. I suggest that we reexamine a reduction in their income tax, improvement of food supply (meat, dairy products, fruit), which will necessitate at least a temporary reduction in the supply to the Union-Wide Fund from Vostochno-Kazakhstanskaya Oblast. Consideration should be given to evacuating children to vacation homes and forest schools.

But even that is not enough. I believe that the accident in Ust-Kamenogorsk should serve as a hard lesson to all agencies, including my "alma mater," the USSR Ministry of Nonferrous Metallurgy. Finally, we have to make a decision to shut down all unhealthy plants, to repair and adjust all ecological facilities. Where are we going to get the money? With consideration of new approaches to taxing industrial enterprises, provisions must be made for reducing for a certain time the deductions to the State budget for higher agencies. This will enable us to direct the money saved to target ecological programs, and to reduce the probability of new disasters.

Two Minutes Before Explosion

917M0024A Moscow *RABOCHAYA TRIBUNA*
in Russian No 258, 13 Nov 90 p 4

[Interview with Colonel Vladimir Borisovich Varakin by A. Vitkovskiy, Center of Joint Communiqués, KGB, USSR; place and date not given]

[Text] From code to Watch Service, KGB, USSR:

"...On 28 July 1990 at about 5:00 AM there was an explosion at a transformer substation of the 'Kommunar' Gold Mine. No one was killed. A group sent to the site of the accident, including a pyrotechnics expert, official investigators and operatives of the UKGB and UVD of Khakas Autonomous Oblast found clues suggesting the presence of a home-made explosive device.

"In the vicinity of the pumping station, another device was found with the timer set at 5:00 AM. However, with two minutes to go, at 4:58, for reasons as yet unexplained, the clock had stopped. Criminal action has been brought in the case, and steps are being taken to find the perpetrators."

Vitkovskiy: Vladimir Borisovich, first a few words about what you and your colleagues call the operative situation.

Varakin: Every year, several hundreds of major accidents and fires are reported in the nation's industrial enterprises alone. As many as 14,000 people die in these incidents. Consider these figures: every day 35-40 people do not come home from work, and never will.

Vitkovskiy: Indeed, a terrible statistic. And does the KGB take part in investigations of every accident?

Varakin: We investigate the most serious ones, and especially those where we have reason to suspect premeditation. And alas, there is plenty of such work these days. In 1989 and the first half of 1990 alone, the KGB has taken part in investigations of 170 explosions, fires and cave-ins. The direct material loss from these incidents was more than 100 million rubles, 160 people died, and 550 were severely mutilated and traumatized. Premeditation was established in 12 cases, including with criminal intent.

For example, there was the affair of a foreman at a missile plant in Anisin. He was systematically putting metal objects into crucial engine components. And it wasn't enough that many millions of rubles were being lost. Later on at his trial, this piece of trash tried to make the case that this was his way of fighting for peace. The court gave the saboteur the maximum sentence.

From Code to Watch Service, KGB, USSR:

"...In the process of looking for persons who might have been involved in the explosions at the 'Kommunar' Gold Mine, information has been obtained to the effect that two unknown men were seen on nearby hillsides on the eve of the incident. They set up a tent on a site inconvenient for resting, camouflaging it so that it would not be noticed from the industrial area. Examination of the aforementioned site turned up three bottles of flammable liquid, two light bulbs, and some wire. The nearby territory is clearly visible from the tent, including the vicinity of the explosion."

Vitkovskiy: Investigation of accidents of this kind is probably among the most important areas of activity of workers in the Extraordinary Commission. What are other problems dealt with by your service?

Varakin: What you might call our main line is prevention of premeditated acts aimed at undermining the economic basis of the state, any accidents that involve the destruction and ruin of equipment, or the death of people. Each year we report to ministries and agencies, and to the administrations of enterprises about preconditions for serious accidents that require immediate response. We send out about 2500 such messages per year.

And sadly, there is plenty of cause for alarm. Preconditions for tragic accidents are uncovered nearly every day. The disasters that we prevent, the lives, millions of rubles and enormous resources that we save do not show up in statistics. Ultimately, only the accident that happens makes its dreadful claim. And yet, to take an

example, just a year prior to the Bashkir disaster, KGB workers in Kurgan Oblast and Bashkiria were warning about the possible explosion of the gas mixture in the vicinity of the all-product pipeline in the case of simultaneous passage of two trains. However, the response to this information, as you now know, came too late. Incidentally, a spot check on the West Siberia-Ural-Povolzhye all-product pipeline has revealed about 500 significant defects that also might result in unjustified accidents. A total of roughly 200 main pipelines and facilities of the petroleum and gas industry have been additionally studied. The USSR Council of Ministers now has a complete picture of the actual state of affairs.

Vitkovskiy: What branch of industry in our nation is now your greatest concern?

Varakin: It would be hard to say right now. Let me put it this way: we are giving our greatest attention to the most dangerous facilities and plants, places where accidents and actions of the ill-intentioned might result in really serious consequences. Primarily, this relates to nuclear power, chemical plants, the defense industry.

Vitkovskiy: But after all, they are being watched by their own control services.

Varakin: And do you think that operative control is going to get in their way? The more so as everyone knows that there is no such thing as an absolutely safe production facility. Let me back that up with an example: in the past two years, KGB agencies have received more than 200 reports about dangerous preconditions for disruption of technological processes in nuclear electric power plants. And to put it bluntly, about the completely careless attitude that reigns at times even in such dangerous facilities. Naturally, we warn the directorate about this. But as a rule, the response will be alibis, allusions, no money, no resources.

Vitkovskiy: As if cleaning up the consequences of nuclear accidents were cheaper.

Varakin: Exactly. To the aforementioned we should add main petroleum, gas and all-product pipelines. Nearly all of them are potentially hazardous. Hundreds of defective water crossings, thousands of kilometers of broken waterproofing, substandard welds, lack of cathodic protection and many other things make the danger associated with possible disasters here lethal in the true sense of the word.

Serious situations arise with liquid chlorine and other toxic materials. For example, four people died and more than forty were poisoned last spring at the Ionava "Azot" Association because of a leak in a tank of liquid ammonia. A cloud of poison gas spread over nearby areas.

Recently the problem of recycling radioactive materials and their wastes is making itself more and more acutely felt. Way back when intensive research was starting in

this field, nobody was thinking about means of protection. As a result, there are now about 500 areas with sources of intense radioactive emission in Moscow alone. And similar sources are to be found in Moscow suburbs, and in the oblasts of Tula, Kaluga, and elsewhere.

Vitkovskiy: Vladimir Borisovich, what are the summands of this tragic arithmetic? After all, it is not some blustering primordial force, but rather a menace created by their own hands that is taking people's lives.

Varakin: The direct causes of accidents always turn out to be gross violations of safety rules, operation of malfunctioning or worn out equipment, technological violations. These are what we might call first-level causes. The next part of the problem involves imperfect designs, sloppy construction, skimping on equipment. But for all that, the main aspect of the problem is personal. According to computations by specialists, most capital investment today still goes for hardware. Yet ninety percent of accidents are due totally to the human factor. What precisely? Take the example of rush work for the sake of turning in triumphant reports on "putting facilities into operation ahead of schedule." And then there is the personal egotism of some directors who are just aching to get awards and move up through the ranks. Not to mention carelessness and negligence to the point of idiocy. Here we have cases that are just one of a kind. For example: several legs of a gas line laid in direct proximity to an air force proving ground used for training in bombing and missile firing.

Vitkovskiy: Still, this is a unique case. But among the disasters there must be, for want of a better term, some that are ordinary, run-of-the-mill...

Varakin: The coal mining industry has recently had a rash of explosions, fires and cave-ins. An example of the latter: at the Dimitrov Mine of "Kuznetskugol" Company, failure to observe safety rules in mining resulted in a breach of water into a coal stall, killing 11 miners. And it is under these circumstances that there is a cutback in supervisory and monitoring services at the initiative of several labor collectives. The increasingly prevalent attempts to save a ruble at the expense of safety is being turned around to the loss of human lives.

Vitkovskiy: But then, can't they be brought to court for this?

Varakin: So who's afraid of that? It's no secret that criminal trials relating to accidents usually turn into "for lack of elements of a crime in the actions of the persons charged." In the last three years, trials on 26 major accidents in which 88 people were killed and 35 were severely mutilated, ended essentially without result. None of those responsible for the accidents received any criminal punishment.

Vitkovskiy: Then what can be said about your disclosure of preconditions for accidents?

Varakin: Unfortunately, precautionary information is simply ignored in many cases. Or else the time for taking emergency steps is inadmissibly dragged out. This is just the state of affairs that has come to pass at a facility of the Ministry of the Chemistry and Petroleum Industry in Nizhegorodskiy Oblast. The force of an ethylene oxide explosion there in case of a major accident might be three or four times the destructive power of the atomic bomb dropped on Hiroshima. I am intentionally not naming this facility, as the ministry has finally made a start on reducing the hazard there. However, specialists feel that these efforts are inadequate. Still, implementation of more effective measures would necessitate a change in the original plans and major capital investments.

Vitkovskiy: Would you tell us just what your sources of information are, and to what extent they are objective?

Varakin: We have highly skilled workers who are college graduates in many fields of engineering, and who have been trained at KGB educational institutions. Along with this, we can ask for assistance from specialists working directly at certain enterprises. In addition, we have access to informer data. And no one should be embarrassed by that. We are talking about human lives and state security in the fullest sense of that word.

Vitkovskiy: But why should the KGB deal with problems of industrial safety at all?

Varakin: But really, is the matter any worse for that? After all, we frequently come under agency control, in the best case for the information of our own agency. Even external agency control has not proved its independence, unless you count the actively operating Gospromotomenergoadzor. I won't even discuss the so-called people's control. And so it falls to us to deal with the heritage of years of irresponsibility. However, conditions are changing, and the time has now come for the most radical measures, chiefly economic. I believe that a kind of division of functional duties will be needed in a market economy. The collectives of leased or joint-stock enterprises will have to be independently concerned about preventing accidents in their own companies, and to take the full measure of that responsibility. Then we will have greater opportunities for concentrating our attention on rooting out extremists and preventing acts of sabotage. Then our operations will be an integral part of the program developed by the State Committee of the USSR Council of Ministers on Emergency Situations for prevention and cleanup of accidents. It goes without saying that the activity of bodies of state security should be coordinated with the operation of other bodies and agencies for protecting law and order.

In my opinion, all of the foregoing should find reflection in the Law on the Committee of State Security of the USSR. And while we're on the subject, a closer watch should be kept on defense and crucial national economic facilities where major accidents could have the most dire consequences.

From code to Watch Service, KGB, USSR:

"As a result of operative inquiries and investigatory work concerning the explosion at the 'Kommunar' Gold Mine, the perpetrators have been identified. They are K.-, year of birth 1964 and Ye.-, year of birth 1962 with prior convictions for general crimes. They were observed in the guise of 'relaxing' in a tent shortly before the incident in the vicinity of the industrial site. In the course of procedural actions, the suspects gave testimonies of involvement in the explosion. Their confessions were corroborated by reconstructions of the crime. Evidence shows that one of their motives for setting off the explosion was a competitive fight for a job assignment between the assiduous 'Sayany' crew who had been granted a gold washing contract, and the 'Sibir' crew where the detainees were working."

Chemistry Against 'Chemistry'

907M0210A Moscow PRAVDA in Russian No 96,
6 Apr 90 p 4

[Article by R. Fedorov]

[Text] "Man introduced into the planet's structure a new form of action of living matter upon the exchange of atoms between living matter and inert material. Before, organisms influenced the history only of those atoms which were needed for their growth, reproduction, nutrition and respiration. Man widened this circle, influencing elements needed for technology and for the creation of civilized forms of life.... From a geochemical point of view, all of these products—masses of free metals such as metallic aluminum that had never existed on earth, iron, tin or zinc, masses of carbon dioxide produced by the roasting of lime or the burning of coal, the enormous quantities of sulfuric anhydride or hydrogen sulfide formed in chemical and metallurgical processes, and the ever-increasing quantity of other technical products—do not differ from minerals. They alter the unceasing course of geochemical cycles. With further growth of civilization, the influence of these processes should continually increase...."

An alarming situation. If we look carefully at what V. I. Vernadskiy meant by these words, we would find that the scientist was essentially warning us of this situation long before it came to pass. But we failed to heed his words, and today we are going on as if the dangerous limit had come upon us suddenly. Our first reaction has been a unique sort of "ecological Luddism": shutting down chemical, metallurgical and power engineering enterprises. However, the reason we built them—we read V. I. Vernadskiy once again—was "for the creation of civilized forms of life." Without them, we'll have to return, if not to the Stone Age then to the not at all fortunate Middle Ages, with their epidemics of plague and cholera, and with armed invasions of the lands of the nearest neighbors or overseas countries in the hope of getting rich. Anyway, the choice was already made long ago in the half-serious "folk" saying that it is better to be

healthy and rich than poor and sick. The path to wealth and health is precisely in development of production, and not its shut-down. But can it be ecologically clean?

A general assembly of the USSR Academy of Sciences was holding meetings in Moscow State University's auditorium on the Lenin Hills. There was an exhibit in the foyer—the academy's chemical institutes were explaining their projects which were opening up the paths to ecologically clean chemistry.

But are these projects not "half-baked," are they not an expression of current fads, and a concession to the onslaught of the public, which is so critical of chemistry? These were the questions I asked of Academician O. M. Nefedov, vice president of the USSR Academy of Sciences.

"They reflect the logic of the development and improvement of science, and its present concerns. The modern level of fundamental research inescapably leads to effective technological concepts, and it is the civic duty of the scientists to promote their practical introduction.

"The developments are varied and multifaceted. But even a nonspecialist can clearly discern two fundamental directions uniting many of them: new effective catalysts for chemical reactions, and new sorbents that trap even extremely tiny quantities of substances from suspensions and solutions.

"The significance of catalysts is very great," the scientist went on. "In particular, they allow us to deepen the degree of raw material processing. And in this way we can dramatically reduce relative consumption of raw materials and energy per unit of product; this is a direct service to ecology, to preservation of the environment. New production procedures based on their application make processes more selective, they make them oriented selectively on acquisition of a clean end product, and they permit such processes to go on in reactors of significantly smaller volume. Neutralization and even recycling of exhausts and wastes become possible with them. As an example sulfuric anhydride from flue gases may be transformed into pure elemental sulfur. Combination of catalysis with membrane technology opens up even greater possibilities."

The Institute of Organic Chemistry imeni N. D. Zelinskiy, the Institute of Petrochemical Synthesis imeni A. V. Topchiyev and other of the academy's scientific institutions displayed new catalytic processes that effectively solve nature protection problems.

"As far as the new sorbents are concerned," O. M. Nefedov notes, "unfortunately, at the moment only one part of the problem is solved most effectively with them—treatment of gaseous and liquid wastes, removal of substances from them which may harm the environment. We are seeing a need for urgent solution of another part of this problem—recovering and utilizing these "trapped" substances. Study of chemical precipitation processes employing flocculants and development of

microbiological methods of extracting substances from wastes which could then be returned to production or which could serve as raw material may be interesting in this aspect."

New, effective sorbents are displayed at the exhibit, for example, by the Elementoorganic Compounds Institute imeni A. N. Nesmeyanov and the Geochemistry and Analytical Chemistry Institute imeni V. I. Vernadskiy. The proposals of the latter are oriented to a great degree on creating high precision methods of analyzing the concentrations of small quantities of substances in natural media—soil, water and air. But as was explained to me by Doctor of Chemical Sciences B. F. Myasoyedov, the institute's assistant director, sorbents developed by the institute are being currently used in Norilsk in an attempt to extract platinum and other valuable components contained in extremely small quantities in the tailings of ore enriching processes.

A detailed description of the procedures displayed in the exhibit would be of interest only to specialists, and those desiring to do so may acquaint themselves with them either at the institutes themselves or in the Exhibition of the Achievements of the USSR National Economy, which is where the displays are to go next.

The works displayed at the exhibit persuasively show that chemistry is fully capable of fighting against "chemistry"—that is, the harmful sides of chemical production operations and the undesirable consequences of using their products. The thing to do now is to widely introduce scientific developments and achieve high culture in production and use of products, without which it would be impossible to achieve "creation of civilized forms of life."

"Wrap up America!"

907M0210B Moscow *RABOCHAYA TRIBUNA*
in Russian No 67, 22 Mar 90 p 3

[Article by Aleksandr Vinyukov, electrician, Mine imeni Lenin, Mezhdurechensk, Kemerovo Oblast]

[Text] "As our delegation was leaving this fabulous country, we were asked what we would wish to take back with us. I replied: 'Wrap up America!'" That is what miner Aleksandr Vinyukov said in an interview. After a month-long trip to America (at the invitation of American trade unions) Aleksandr returned to the remote Siberian city of Mezhdurechensk. "Well, what did you find there? And how much did it cost?" the women of Mezhdurechensk showered him with questions. But Aleksandr reduced everything to "prose"—to the activities of the trade unions, to their role in the life of American laborers, and to matters close to the hearts of miners.

Prior to our take-off for America we met with a representative from the international department of the AUCCTU, who made a long-winded attempt to convince us how "bad" the trade unions are in comparison to ours. Then 11 hours 40 minutes of air time brought us

The chief engineer read us the safety regulations, and we signed a waiver releasing the company from responsibility for us. We were wearing our best—suits, shirts and ties. We were given overalls, which we donned right over our good suits. We spent 2 hours in the mine, and we even visited the face where the continuous miner was

working. We talked to each other in a normal manner (in our mine, we have to shout into each other's ears at the face).

When we returned to the surface we were given an opportunity to wash our hands and freshen up. We put our ties back on, and then we went on our way. Dust at the face is kept down by a huge sprinkling system, but strange as it may seem, there was no water in the longwall. It settles as a fine mist.

The second mine we visited belongs to Pitston. It employs 340 persons. Annual output is 2 million tons of coal. I asked one of the mine's executives how much coal the mine could really put out. He asked me how much I would want.

"Could it do 6 million?"

"Sure."

"What about 8?"

"It can do 8, and it can do 10."

"Does that mean that you would have to hire more workers?"

"No. We'd simply run the machinery at full load. The mine's output depends on the demand for coal."

We visited one of the faces in which a system manufactured by the Joy company was operating. As a rule the equipment is American, but English and West German equipment can be seen as well. A miner working at the face does so without breathing equipment. One of his duties is to measure the gas and dust conditions mandatorily every 20 minutes. If levels rise in the course of 3 days, an inspector comes from the trade union and shuts down the mine. No matter whose fault it is that a face is shut down, a miner continues to receive his \$16.50 per hour.

A work shift consists of eight hours. This also includes round-trip travel between the shaft entrance and the face. The net working time is five and a half hours. Only pilots receive a higher hourly wage than miners. The minimum wage in the USA—\$3.35 per hour—is earned by technicians, housemaids and waiters. But the latter also receive tips officially—15 percent of your check. Is this a stimulus for good, honest work? Yes!

An engineer receives 15-20 percent more than a worker.

American miners can earn significantly more—there is no prohibition on working on Saturdays or Sundays. On these days they are paid double-time, and even triple-time.

How do wages relate to prices? Let me use the cost of motor vehicles as an example. A Dodge microbus or a Ford microbus seating nine costs around \$20,000, while a Plymouth microbus costs \$16,000. A Mercedes is more. Workers prefer the practical and inexpensive Chevrolets and Plymouths. I was asked if I had a car.

Yes, I said, a Zaporozhets. My hosts went into a huddle, and when they emerged after a while, they respectfully asked me what sort of brand this was. I searched in my mind for something to compare it with, but I was unable to find a local analog of this unique motor vehicle.

Let me present a few more facts that workers of our Ministry of Coal Industry might think about. In 1976 the Americans mined 650 million tons of coal, and the sector employed 250,000 persons. In 1988 the number of miners was 160,000, while annual extraction jumped to 950 million tons. We have 2.5 million miners who extract 730 million tons of coal. How do we explain this difference?

There was one other fact that caused me to ponder. An average of 50 percent of the coal reserves of any given mine are mined—that is, half of the coal remains beneath the ground. We asked why this fuel was not being utilized properly, and how much of a supply there was. There was enough for 300 years, they replied. By that time mankind will be doing even without coal, having found other energy substitutes.

The USA's explored coal reserves are 4 trillion tons. The potential reserves are 45 million tons. The thickness of the seams is from 1.3 to 3 meters. The slope of the seams is up to 45 degrees.

And another thing: The Americans extract 60 percent of their coal by the open pit method—significantly more than in our country. Unfortunately we were unable to visit an open pit, but I think that as is the case with the local mines, we would not have seen the extreme devastation typical of the Kuznetsk Basin. This is a different level of culture. Here is at least one example. Our delegation included a representative from the Saturn Construction Cooperative—Boris Grebenyuk from Donetsk. He worked for 13 years in a mine, and he submitted around 100 efficiency proposals and inventions, but he was never able to push them through. On learning of this, the Joy company immediately signed a contract with him.

There might be those who would exclaim with displeasure: "There he goes, praising America!" Praising.... But there are some things to learn from this country and its people. What is particularly interesting is that these are just plain old people, like us. During the day you might see streetlights still on, and you might encounter a woman in tattered clothing. All of this confirms a simple truth: They still have considerable reserves for economization, as we might say. They have rich and poor, they have workaholics and parasites. But very great is the desire of ordinary Americans and their leaders to live the simple life. This powerful desire, which has made America different from us, is what I asked them to wrap up for me as a sample.

And one last thing. When we returned, there were people who accused our delegation of being "bought out" by the American trade unions. I feel this to be a cheap shot, and an impertinence. If our trade unions, with the AUCCTU

at their head, wished to preach the "raw" truth about the life of the American working class in a way advantageous to them, I would disagree deeply with such a "truth." And I express my open thanks for the visit to America not to the AUCCTU, to which I have paid large amounts in dues out of my personal budget, without knowing why, but to the AFL-CIO.

In the USSR Council of Ministers State Commission for Extraordinary Situations

907M0210C Moscow *RABOCHAYA TRIBUNA*
in Russian No 80, 6 Apr 90 p 2

[Text] The matter of fulfilling the 12 June 1987 decree of the USSR Council of Ministers and other decisions of the USSR government concerning protection of the environment in the city of Kemerovo was examined at a regular meeting of the USSR Council of Ministers State Commission for Extraordinary Situations.

The commission, the meeting of which was conducted by USSR Council of Ministers Deputy Chairman V. Kh. Doguzhiyev, noted that emissions of pollutants into the environment were reduced by 20 percent as a result of measures adopted in 1987-1989 to build treatment plants in Kemerovo and to shut down obsolete production operations at enterprises of the Agrokhim [State Agrochemical Association], of the USSR Minkhimneftprom [Ministry of Chemical and Petroleum Refining Industry] and the USSR Ministry of Metallurgy. Five thousand persons were moved out of the health protection zones of industrial enterprises located in Kemerovo.

At the same time the commission turned the attention of USSR ministers Yu. K. Semenov, S. V. Kolpakov, N. V. Lemayev, M. I. Shchadov and B. M. Belousov and State Agrochemical Association chairman N. M. Olshanskiy to the fact that the ecological situation in Kemerovo remains stressful, and that the main sources of pollution are enterprises of the USSR Ministry of Power and Electrification, the USSR Ministry of Metallurgy, the USSR Minkhimneftprom, the USSR Ministry of Coal Industry, the USSR Ministry of Defense Industry and the Agrokhim.

On certain days, especially in unfavorable weather, the mean daily concentrations of toxic substances in the city's air basin exceed the established public health norms by several orders of magnitude.

Further improvement of the ecological situation in the city is being held back in many ways due to insufficient attention toward construction of nature protection facilities on the part of the Kemerovo Oblast Executive Committee, which has been granted the right to independently determine the directions of use of capital investments, and on the part of the RSFSR Ministry of Construction in the Urals and Siberia. Construction of nature protection facilities in Kemerovo was practically halted in 1989. Analysis of the 1990 plan for building these facilities shows that the situation is not changing.

A number of specific measures to improve the material and equipment base of Kemerovo's construction organizations, to increase the volume of construction of nature protection facilities of industrial enterprises located in Kemerovo on a self-help basis, to resettle citizens residing in the health protection zones of these enterprises, to convert the power plants of Kemerovo and the boiler plants of the city's Rudnichnyy Rayon to gaseous fuel, to reduce emissions of pollutants into the city's air basin together with the exhausts of internal combustion engines, and to improve the system for monitoring pollution of the atmosphere in Kemerovo and the waters of the Tomi River were spelled out in a decision adopted in regard to this issue.

The commission noted that USSR Ministry of Metallurgy had not fulfilled the 12 June 1987 decree of the USSR Council of Ministers in regard to shutting down coking battery No 4, and ordered S. V. Kolpakov to complete this assignment within a month's time. The ministry was ordered to draw up within a month's time, and submit to the USSR Council of Ministers, proposals coordinated with the Kemerovo City Executive Committee on job placement and material and personal support to unemployed workers and their families, and to solve other social problems associated with shut-down of the battery. At the same time the commission recommended to the USSR Ministry of Metallurgy, the Kemerovo Oblast Executive and the Kemerovo City Executive Committee that they examine, with the participation of the USSR State Committee for Protection of the Environment, the USSR Ministry of Health, scientists, specialists and representatives of the public, a request from the labor collective of the Kemerovo By-Product Coke Plant to extend the time of operation of coking battery No 4, and if necessary, to submit coordinated proposals to the USSR Council of Ministers.

Shop Explosion

907M0210D Kiev *PRAVDA UKRAINY* in Russian
21 Feb 90 p 4

[Article by M. Berezovskiy, associate of the UkSSR Ministry of Internal Affairs Press Center]

[Text] An explosion of a hydrogen mixture occurred in the pure hydrogen section of one of the shops of Rovno's Azot Production Association at 1020 hours on 19 February.

The explosion completely destroyed the shop building and partially destroyed some other buildings. Six out of seven workers in the shop suffered bodily injury. Two of them were pronounced dead at the scene, and three were hospitalized. One of them is in serious condition.

The industrial facility was an experimental one, the first in operation in USSR chemical industry. It was being used to introduce a new membrane procedure of hydrogen acquisition. The estimated cost of this facility was 2.5 million rubles. Now it no longer exists—the concrete ceiling-floors, the metallic framework and the

expensive equipment were all destroyed. But the greatest loss was doubtlessly the people.

The cause of the explosion is under investigation.

Poisoners as Neighbors

907M0210E Moscow *RABOCHAYA TRIBUNA*
in Russian No 80, 6 Apr 90 p 3

[Article by V. Luchin, chairman of the council of the Kupavna Ecological Society]

[Text] I read the article "Lead 'Delights'" in *RABOCHAYA TRIBUNA*, and I agree entirely with the newspaper's approach to the issue.

The ecological situation in Kupavna is extremely critical even on the backdrop of the generally unfavorable conditions of Noginskiy Rayon.

A large quantity of chemical enterprises using antideluvian production procedures are concentrated here, and even these procedures are often violated. The absence of effective treatment plants, the inadequate capacity of the industrial sewer system and many other causes have resulted in excessive contamination of the soil, of surface and ground water and of the air.

Huge waste dumps of the Akrikhin Combine, which have been around since the 1930s, and the slag piles and local treatment plants that have outlived their day have poisoned the water-bearing horizons to a depth of over a hundred meters, and they will continue to poison them long into the future. As a result the water of artesian wells, including drinking water sources, has become unusable not only for drinking but also in a number of cases for industrial needs.

Each day Akrikhin dumps 12,000 cubic meters of such water—after adding its own industrial wastes to it—into the Shalovka River, which then poisons not just the Klyazma but also the Oka and the Volga. Akrikhin's caustic wastes are being detected as far away as the Caspian Sea.

But consider that besides Akrikhin, the same is also being done by the Khimreaktivkomplekt Plant, by the bases of the Khimreaktivy No 1 and Moskhimsnabsbyt, by the Progress All-Union Scientific-Production Association, and others.

A huge quantity of chemicals and of strong-acting toxic and radioactive substances accumulated near the residential districts of Kupavna may cause a disaster at any moment with unpredictable consequences.

The unfavorable ecological situation is having a deleterious effect on the health of residents, and children especially. Last year there was a phosphorus oxychloride leak at Akrikhin. This substance is not inferior in its toxicity to methylisocyanate (MIC), well known as a

result of the tragedy in the Indian city of Bhopal. Three thousand people perished there, and 100,000 remain disabled.

Only chance saved our residents from misfortune. That day the wind was blowing in the other direction. It turns out that the Akrikhin Combine produces MIC as well; moreover the conditions of its production do not satisfy the requirements of a hazard class 1 (highest) production operation. It is transported at the combine in glass containers. Were the bottles to break.... Are we once again laying our hopes on luck?

Adults, including teachers at day care centers and nurseries, keep gas masks available for such an event in Kupavna. And the children keep gauze face masks handy.

Should their health depend solely on wind direction and luck?

Legends of 'Living Water'

907M0210F Moscow *RABOCHAYA TRIBUNA*
in Russian No 77, 3 Apr 90 p 4

[Article by A. Sokolov]

[Text] Use of magnetotrons raises the yield of cereal crops by 5-10 centners. Animals drinking magnetized water gain weight more quickly. Magnetotrons increase the power of motor vehicle engines and raise the strength of concrete.

He wore neither a cape nor a magician's hat. Nor did he have a wand. But that which the master of the laboratory created had all the appearances of magic.

First he took from me the cigarette I was about to light up, and passed it through a polystyrene tube. I could not believe my nose: The cigarette suddenly began exuding the aroma of select tobacco. Red wine poured through the same tube clarified, and its bouquet became richer and more delicate. Ordinary water that would not pass through a fine sieve went through immediately after being passed through the tube. It was as if someone had enlarged the microscopic pores with an invisible hand. Before my very eyes, water and other substances changed their physical and chemical properties.

It has already been a dozen years that inventor Valentin Patrasenko has been creating all of these "miracles." And all of these "magic tricks" may be demonstrated by any schoolchild, were he to be given one of the devices developed by the talented inventor.

They are called magnetotrons. While the first part of the name needs no explanation, the latter signifies a receptacle of energy—magnetic in this case.

The author has developed and designed over 20 types of magnetotrons. They have been tested in the fields and in plant shops, in scientific research institutes of various orientations, and in medical clinics. The results have been more than persuasive.

A year ago Valentin Patrasenko founded and assumed the leadership of the Northern Caucasian Regional Cost-Accounting Magnitotron Scientific and Technical Center, the country's first, within the framework of the All-Union Committee for Problems of Energy Information Exchange in Nature.

What does Magnitotron have in common with a committee involved in the study of anomalies such as poltergeists, telekinesis and biological fields?, the reader may ask. Magnetotrons create a field identical to man's biological field. It was measured, specific contours were imparted to it, and it was put to work.

My questions are addressed to a full member of the USSR Federation of Engineers and deputy chairman of the All-Union Association of Magnetobiology and Magnetotherapy under the USSR Ministry of Health.

Sokolov: What are the objectives being sought by Magnitotron?

Patrasenko: The problem of energy information exchange in nature is so complex, new and vast that there is enough work for dozens of scientific institutes. But perhaps the main thing is that the stage of dogmatic rejection of it is behind us, and study of the problem has been recognized as a fundamentally new direction in science.

But this is only the beginning. The task before us is to make Man and Nature friends. The center has taken responsibility for the most important part of the work on bioenergetics and magnetology.

Our program is a serious scientific and production effort aimed at implementing magnetic effects in the national economy and in medicine, and creating nonchemical, ecologically clean production processes.

On the whole, the universality of the use of magnetotrons is astounding! Medical specialists note that magnetotrons are fabulous doctors. The magnetic field created by a magnetotron has a positive effect in the treatment of respiratory organs and various forms of tuberculosis and gynecological diseases.

Use of magnetized medications significantly reduces the time of treatment of eye diseases, and magnetotrons are used for treatment and preventive purposes in stomatology.

Magnetized water is truly "living water." Drinking 30-50 grams of it before eating has a therapeutic and preventive effect in the presence of gastrointestinal diseases, cholecystitis, kidney stones, urological diseases, and nervous and mental disorders; it decreases blood pressure, improves the work of the cardiovascular system, raises the body's resistance to colds, induces sounder sleep, and reduces fatigue.

Sokolov: The center's developments are more than attractive. But we hear so much today about various

sorts of innovations that doubts sometimes creep in: Is all of this not just sleight of hand?

Patrasenko: Discussing the center's program, I emphasize throughout that we are involved in development and introduction. We have our own experimental production operation. But the main thing is that we are prepared to furnish the devices and instruments we develop to operating enterprises and cooperatives on mutually advantageous terms. For example large-scale production of magnetotrons to be used in magnetizing water systems in engineering, biology, agriculture and medicine has now been organized in the oblast. Anyone who has tried them at least once will no longer reject their use. Unfortunately, many of our developments have not made their way to the people, or they are manufactured in small quantities—the trade system is not sufficiently interested.

But there are also examples of a different sort. We are now producing magnetic clips for auricular (point) magnetotherapy. Acupuncture has been around for a long time in Eastern medicine. There are more than 200 biologically active points on the human ear associated with particular organs or centers controlling these organs. Through these points, the clips stimulate the body's work. In general these clips should enter the inventory of every modern person, together with handkerchiefs and compacts, and among patients they should replace boxes of validol. In just minutes they normalize arterial pressure, adjust the state of the cardiovascular system, and relieve headaches and bodily discomforts. They are effective against diseases of the respiratory organs, colds and medicinal toxicosis, and they are irreplaceable on the road—they help fight nausea on land, on water and in the air, they are essential in the presence of stressful states and overtiring, and they assist in adaptation to extreme conditions. There is no better resource in the presence of magnetic storms and other abrupt temperature fluctuations.

One short mention of these clips in the central press elicited literally a storm, an avalanche of letters and telegrams—8 million!!!

Sokolov: Yes, I have seen such clips in different corners of the country. Is your center really so omnipresent that it is able to sell them both in airports and in commercial stores?

Patrasenko: What we should be talking about is not omnipresence but economic banditry, which is possible perhaps only in our country.

There is only one instrument developed by Magnitotron and approved by the USSR Ministry of Health, as also there is but one set of instructions on its use. Being the inventor, I am very flattered that our development is so popular in the commercial market as well. But in a rush for immediate gain, dozens of cooperatives not possessing the design documentation have literally filled the

market with imitation clips which do not satisfy elementary requirements, have not undergone clinical testing, and are not approved by the USSR Ministry of Health.

Sokolov: Your developments are specific, and your ties are extensive. What next?

Patrasenko: Each day the center gives birth to new ideas and welcomes talented visiting scientists. We want to help these enthusiastic scientists. We are creating folk medicine centers providing the full complement of services in the Caucasus and in the Moscow region. We are setting up contacts with foreign partners. The programs have already been written, and several joint ventures have begun work.

Sokolov: We expect to receive a great deal of mail from readers in response to this article. I am certain that there will be people among them who might have ideas and proposals useful to the center. How would they get in touch with you?

Patrasenko: I would be grateful to RABOCHAYA TRIBUNA if they could communicate with me through its mailbox—if this would be possible, of course. The information center Magnitotron is establishing will make it possible to collect an unusual data bank on abnormal

phenomena, and about all kinds of things that seem interesting and unusual which man encounters in nature. We would be grateful if readers could communicate to us the names of any persons they know with extrasensory capabilities. We certify them, and we help them obtain the right to engage in practical activities—to heal, to seek minerals, to make predictions.

Using complex and original equipment, our specialists will be able to look into the "soul" of wizards and "converse" with poltergeists. By systematizing the facts which nature presents to us in such abundance we'll help scientists to understand the secrets of our world, and to place the unusual phenomena of nature in the service of man.

P.S. At the time this article was being prepared for publication, a message came in from the Ministry of Health: New developments of Magnitotron intended for magnetotherapy with a wide range of action were approved. These new items, as well as the well-recommended magnetic clips, may be ordered from the following address: 344064, Rostov-on-Don, Dachnaya Street, 8. A special correspondence sorting division is working in the postal department.

Effect of the Structure of Ion Implantation on the Structure of the Surface Layers of High-Strength Alloys

917M0039A Moscow FIZIKA I KHIMIYA
OBRABOTKI MATERIALOV in Russian No 6,
Nov-Dec 90 (manuscript received 11 Oct 89) pp 22-24

[Article by N.A. Olshevskiy, L.Ye. Rodkina, and Ye.G. Grechikhina, Moscow]

UDC 539.211:539.1.043

[Abstract] The goal of the study reported herein was to determine the structural changes occurring both during low energy implantation of nitrogen ions and during combined treatment of construction alloys on an iron-nickel (EP-718) base and on a titanium (VTZ-1) base (both of which are widely used in manufacturing domestic machinery components). Specimens of the alloy EP-718 were irradiated with nitrogen atoms with an energy ranging from 5 to 10 keV in doses of 10^{17} - 10^{18} ions/cm² at temperatures of 150 and 530°C. Specimens of the alloy VTZ-1 were irradiated with nitrogen ion flows having analogous energy parameters in conjunction with preliminary heat treatment, preliminary plastic surface deformation, and subsequent heat treatment. Studies of the structural changes in the specimens' surface layers, such as in their phase composition, the parameters of their crystalline lattice, and microdeformation of their surface layer, were conducted by x-ray analysis on a DRON-3.0 diffractometer in filtered CuK_α radiation. Irradiation of specimens of EP-718 did not cause any additional phases close to the surface; however, increasing the specimens' temperature to 530°C during irradiation resulted in the formation of a type Fe_{2.3}N type phase and traces of Fe₂TiO₂ in the near-surface layer with the main structural component being a nickel-based solid solution with a lattice period of 0.3635 ± 0.009 nm. Ion implantation did not result in any qualitative changes in the surface layer of specimens of the alloy VTZ-1 when compared with their initial state. The diffraction patterns obtained from specimens after combined treatment and after surface plastic deformation were found to be close. A small 0.3% increase in the volume of the elementary cell of the α -phase and a 1.5% increase in the volume of the elementary β -phase were discovered. The differences between the changes in the structural and phase states of the surface layers of high-strength alloys based on iron-nickel and titanium that occur after low-energy ion implantation combined with thermal and deformation effects may be explained by the different solubilities of the implanted atoms in the matrix of the irradiated material. Nitride phases and microdefects were discovered in the case of the comparatively low solubility of nitrogen in the surface layers of the iron-nickel alloy, whereas structural changes connected with an increase in the elementary cell of the solid

solution were detected in the case of the comparatively high solubility of the nitrogen in the titanium-based alloy. This finding indicates the solid solution nature of hardening. References 4 (Russian).

Distinctive Features of Mixing a Copper Layer on Molybdenum Under the Effect of Argon Ions With an Energy of 40 keV

917M0039B Moscow FIZIKA I KHIMIYA
OBRABOTKI MATERIALOV in Russian No 6,
Nov-Dec 90 (manuscript received 20 Feb 89) pp 25-28

[Article by A.G. Zholnin, A.M. Borisov, A.A. Panov, and M.N. Smagin, Moscow]

UDC 669.275*3:537.568

[Abstract] A bombarding ion energy above 100 keV is generally used with the ion mixing method. At such energies the effect of atomization may be ignored and the effect of surface relief is insignificant. At lower ion bombardment energies, however, high atomization coefficients with low coating thicknesses limit the irradiation dose and, consequently, the possibilities of the ion mixing method. To compensate for atomization, ion irradiation is conducted with simultaneous sputtering of the coating material. Ion mixing in film-base systems on materials possessing mutual solubility or forming chemical compounds with one another has been rather well studied. Much less research has, however, been devoted to systems with limited mutual solubility, and mutually insoluble materials have been studied only in isolated cases. The study reported herein examined the ion mixing of a pair of mutually insoluble materials, i.e., copper and molybdenum, during irradiation by argon ions with an energy of 40 keV. Technical-grade molybdenum disks (2 mm thick and 14 mm in diameter) that were polished to optical-grade purity and that were coated with copper served as the test specimens. The thickness of the coating on the specimens in the first batch amounted to 10 ± 2 nm, while that of the coatings on the specimens in the other batch amounted to 100 ± 1 nm. The specimens were irradiated in an MIM-50 ion beam unit by a nonseparated beam of argon ions with an accelerating voltage of 40 kV at an ion current density on the target of $26 \mu\text{A}/\text{cm}^2$. The dose at which the specimens in the first batch were irradiated ranged from 2×10^{15} to 3×10^{16} cm⁻², whereas the irradiation dose of the specimens in the second batch reached 9×10^{16} cm⁻². The experiments conducted demonstrated the possibility of ion mixing of a layer of copper on a molybdenum base by argon ions with relatively lower energies. The authors confirmed their hypothesis that at a layer thickness of 10 nm the prevalent mechanism of ion mixing is a cascade mechanism stimulated by bombardment with Ar⁺ ions. At a coating thickness of 100 nm ion mixing is accomplished by Ar⁺⁺ ions, for which the interface is located at the end of the trajectory. Figures 4, table 1; references 7 (Russian).

Structural Transformations and the Behavior of a Phosphorus Impurity in Ion-Implanted Silicon During Rapid Thermal Annealing

917M0039C Moscow FIZIKA I KHIMIYA
OBRABOTKI MATERIALOV in Russian No 6,
Nov-Dec 90 (manuscript received 26 Oct 89) pp 29-32

[Article by P.I. Gayduk, A.V. Demchuk, and N.L. Prokhorenko, Minsk]

UDC 539.219:535.211

[Abstract] Rapid thermal annealing has been successfully used to eliminate radiation defects and activate an implanted dopant in semiconductors. In view of the promise of rapid thermal annealing in VLSI technology, it is very important that information be obtained about the structural state of ion-implanted layers after rapid thermal annealing as a function of such factors as the implantation and annealing parameters and the orientation of the base. The authors of the study reported herein used the method of transmission electron microscopy together with measurements of specific resistance in conjunction with layer-by-layer etching to study the laws governing recrystallization, formation of secondary defects, and activation of the dopant as a function of the conditions of annealing Si<P> ion-implanted layers and the orientation of the base. During the experiments, (111)- and (001)-silicon wafers were implanted with P⁺ ions ($E = 30 \text{ keV}$, $D = 3.1 \times 10^{15} \text{ ion/cm}^2$) with the target at room temperature and suppression of the channeling effect. Rapid thermal annealing was conducted by using halogen lamps in air. From the moment when the lamp was switched on, the annealing lasted between 1 and 12 seconds. The maximum temperature of the annealed specimen ($1,200^\circ\text{C}$) was reached in 7 seconds. The experiments revealed that there are three stages to the annealing process and that the structural state of the ion-implanted layers and activation of the implanted impurity occurring in each stage differ significantly from those in the other stages. The time and temperature bounds of these stages were found to depend significantly on the orientation of the base. The epitaxial recrystallization of the (111)-Si<P> ion-implanted layers was found to be delayed in comparison to that of the (001)-Si<P> layers. This was explained by the crystallographic difference between the atomic nucleation center formation processes and by the increase in the crystalline phase on the (111)- and (001)-planes of silicon, which is just like the situation that occurs during equilibrium annealing or during liquid-phase epitaxial recrystallization. The laws found to govern the formation of secondary defects in the second and third stages of rapid thermal annealing were explained in terms of the differences in the dislocation reactions for (111)- and (001)-silicon under conditions of a shortage of inherent interstitial atoms. Figures 3; references 7 (Western).

Physicochemical Transformations in Chemically Reactive Systems Under the Effect of Pulsed Laser Radiation

917M0039D Moscow FIZIKA I KHIMIYA
OBRABOTKI MATERIALOV in Russian No 6,
Nov-Dec 90 (manuscript received 13 Apr 89) pp 33-42

[Article by S.G. Bychkov, A.A. Biketov, and S.M. Mashakova, Alma-Ata]

UDC 621.375.826

[Abstract] This review examines the main physical phenomena accompanying the effect of pulsed laser radiation on materials. The following topics are covered: the physical mechanisms of the destruction of materials under the effect of a pulsed laser radiation effect, transmission of energy to the target, threshold phenomena, and the mode of progressive destruction. The following points are among the main conclusions presented. The effectiveness of energy transmission to the target during a pulsed laser radiation effect is determined by the optical properties of the initial material, the screening properties of the plasma formation at the target surface, and its capability of re-radiating energy. At power-flow density levels that are acceptable from the standpoint of treating materials, the dominant role belongs to plasma formation, i.e., to its capability of changing not only the amplitude values but also the spatial and time characteristics of the laser radiation. Achievement of the characteristic temperature in the bulk or on the surface of the target is a necessary condition for the realization of threshold phenomena. The induction time depends not only on the power-flow density but also on the relationship between the optical and thermophysical properties of the material out of which the target is made and on the duration of the laser radiation. Mechanoemission is the decisive mechanism of generating the charged particles that result in plasma formation. From a spatial standpoint, the mechanoemission centers coincide with the foreign absorbent inclusions. The thermal or gas dynamic destructive mechanism is determined by the relationship of the heating and vaporization rates and by the pressure and make-up of the gas surrounding the target. The magnitude of the specific recoil momentum communicated to the target is satisfactorily described by the theory of explosion (point and cylindrical). The dynamics of the breakdown of the plasma formation is determined by the curvature of the leading edge of the laser radiation. Figures 2; references 47: 42 Russian, 5 Western.

Effect of Pulsed Laser Rhenium Doping on the Mechanical Properties of the Molybdenum Alloy TsM-10

917M0039E Moscow FIZIKA I KHIMIYA
OBRABOTKI MATERIALOV in Russian No 6,
Nov-Dec 90 (manuscript received 22 Aug 89) pp 48-52

[Article by Ye.S. Vlasova, N.T. Travina, R.Ye. Krzhizhnikovskiy, A.V. Driklenko, and N.I. Kazakova, Moscow]

UDC 535.211:539.219.3

[Abstract] Molybdenum belongs to what has been termed the major quartet of refractory metals (Mo, W, Nb, Ta) and is widely used in industry. Molybdenum and alloys based on it are, however, plagued by one important shortcoming that limits the area in which they may be used. This shortcoming is their loss of plasticity and transition to the brittle state at a specified temperature called the cold shortness threshold. Because the structural state of the near-surface layer is one of the main factors determining the cold shortness temperature, modifying this layer to reduce the cold shortness temperature can significantly expand the applications area of molybdenum and molybdenum-based alloys. For this reason, the authors of the study reported herein subjected a thin near-surface layer of the molybdenum alloy TsM-10 to pulsed laser rhenium doping and studied the effect of such doping on the structure of the layer in question and on the mechanical properties of the alloy. A layer of alloy-forming element about 0.2 μm thick was applied to the specimen surface before laser treatment by vacuum deposition on a Balzers-type unit. The laser pulse treatment was conducted with a solid-state laser based on GOS-301 glass with a wavelength of 1.06×10^{-6} m and a pulse following frequency of 5×10^{-3} Hz. The pulse duration amounted to 40-50 ns, the pulse energy was varied from 1 to 8 J, and the density of the incident energy flux ranged from 5×10^3 to 5×10^5 J/m². Both treated and control specimens were then subjected to various tests. These included mechanical tests, analysis of the distribution of the concentration of alloy-forming element in the near-surface layer, and a study of the topography of the surface and the grain and deformation structure of the specimen in the destruction zone. It was established that creating a thin (about 1 μm thick) near-surface layer with a special structure has a positive effect on a number of very important bulk mechanical properties of the alloy TsM-10; the technique studied increases specimens' plasticity by a minimum of 15-20%, increases their strength by 20%, and reduces the alloy's cold shortness temperature. Figures 5; reference 1 (Russian).

Effect of Pulsed Laser Quenching on the Mechanical Properties of Construction Steels at High Deformation Rates

917M0039F Moscow FIZIKA I KHIMIYA
OBRABOTKI MATERIALOV in Russian No 6,
Nov-Dec 90 (manuscript received 8 Aug 89) pp 58-60

[Article by P.Yu. Kikin, A.A. Medvedev, A.I. Pchelintsev, and Ye.Ye. Rusin, Gorkiy]

UDC 669.018:535.211

[Abstract] Laser quenching is currently being used to modify the surface layer of metals and to thereby increase their strength characteristics and increase the durability of machinery and instrument components made of the metals thus treated. The effect of pulsed

laser treatment on the mechanical properties of construction steels has not yet been sufficiently researched, however. Because such research is interesting from both scientific and practical standpoints, a study was conducted to determine the effect of pulsed laser quenching on the mechanical properties of the steels 45 and 30 KhGSA under conditions of uniaxial compression and extension at deformation rates of 1,000 to 2,500 s⁻¹. Tube-shaped specimens with a wall thickness of 0.9 mm and working section length of 5 mm were subjected to the effect of a YAG:Nd³⁺ laser operating in a free lasing mode. Mechanical tests and metallographic studies performed on the treated specimens revealed that the treatment in question results in the formation of a hardened layer of different depths (0.12 and 0.16 mm, respectively). The mean microhardness of type 45 steel treated specimens amounted to 900 kgf/mm², whereas that of type 30 KhGSA treated specimens amounted to 830 kgf/mm². Treatment of both types of specimens resulted in a noticeable increase in their dynamic elastic limit (a 20% increase for specimens that were laser-quenched to a depth of 0.15 mm, i.e., one-sixth of the specimen's wall thickness). The experiments conducted thus confirmed that pulsed laser quenching can indeed significantly increase the dynamic strength of components made of carbide steels that must operate under conditions of high deformation rates. Figures 2; references 6: 1 Russian, 5 Western.

Experimental Investigation of the Liquation of Components in Sursium-, Gallium-, and Indium-Doped Crystals of Germanium-Silicon Solid Solutions Produced Under Zero-Gravity Conditions on the Kosmos-1645 and Kosmos-1744 Automatic Artificial Earth Satellites

917M0039G Moscow FIZIKA I KHIMIYA
OBRABOTKI MATERIALOV in Russian No 6,
Nov-Dec 90 (manuscript received 12 Jan 90) pp 61-67

[Article by I.N. Belokurova, V.S. Zemskov, A.N. Titkov, D.M. Khavzhu, and V.V. Fedorov, Moscow]

UDC 621.315:536.42

[Abstract] Previous experiments on normal directed crystallization of germanium-silicon solid solutions doped with sursium under zero-gravity conditions during space travel unexpectedly revealed a high nonuniformity in the distribution of the silicon and sursium in the crystals' cross sections. Subsequent research on the problem resulted in the proposal of a model explaining how the laminar flow of the melt along the crystallization front is capable of creating significant nonuniformity. A qualitative criterion characterizing the concentration nonuniformity in the crystals' cross section was proposed: $A = (R^2HK)/DV_0$, where R is the rate of crystallization, H is the crystal's diameter, K is the equilibrium coefficient of the distribution of the alloying component in the melt, D is the coefficient of the diffusion of the component in the melt, and V₀ is the

characteristic velocity of the flow of melt along the crystallization front. It follows from this formula that the concentration nonuniformity should depend on the nature of the alloy-forming additive and the conditions under which the directed crystallization experiment is conducted. This article reports a directed crystallization experiment that was conducted to test the proposed model. During the experiments surmium-, gallium-, and indium-doped crystals were grown from germanium-silicon solid solutions under zero-gravity conditions on board the Kosmos-1645 and Kosmos-1744 artificial earth satellites and under ground conditions. Studies were performed on the crystals grown to determine the distribution of silicon and alloy-forming additives in them. The nonuniformity of the silicon distribution in crystals grown under zero-gravity conditions was higher than in those crystals grown under ground conditions ($\delta = 0.28$ for those grown under zero gravity versus $\delta = 0.10$ for those grown on the ground). The nonuniformity of the distribution of the dopants in the crystals grown under conditions of zero gravity was also higher than in the crystals grown under ground conditions. In the surmium-doped crystals grown under zero-gravity conditions, the areas of the greatest silicon concentration proved to be those of the lowest surmium concentration and vice versa. This same pattern was not observed in the case of those crystals doped with indium and gallium. Figures 2, tables 2; references 5 (Russian).

Liquation of Boron in Germanium Monocrystals During Horizontal Directed Crystallization

917M0039H Moscow FIZIKA I KHIMIYA
OBRABOTKI MATERIALOV in Russian No 6,
Nov-Dec 90 (manuscript received 12 Jan 90) pp 68-70

[Article by I.N. Belokurova, V.S. Zemskov, and D.M. Khavzhu, Moscow]

UDC 621.315

[Abstract] Previous research on the directed crystallization of doped semiconductors under zero-gravity conditions resulted in formulation of the following criterion of concentration nonuniformity: $A = R^2HK/DV_0$, where R is the crystallization rate, H is the crystal diameter, K is the equilibrium coefficient of the distribution of the dopant, D is the coefficient of the diffusion of the dopant in the melt, and V_0 is the characteristic velocity of the melt along the crystallization front. The present study, which is a continuation of this line of research, examines the horizontal directed crystallization of boron-doped germanium under ground conditions for the purpose of verifying and refining the aforementioned mathematical model. Crystals cut from type GES-40 monocrystalline germanium were subjected to recrystallization. The initial crystals were placed in an evacuated quartz ampule containing a hardener in the form of germanium doped with boron to concentrations of 10^{21} at/cm³. To achieve complete homogenization of the melt after part of the initial crystal was melted, the ampule was subjected to

isothermal holding for an hour. The crystals were then grown by taking the ampule from the stationary furnace. The process was conducted at different rates from 1.5×10^{-3} to 2.3×10^{-2} cm/s, and the axial temperature gradient in the furnace amounted to 25°C/cm. Analysis of specimens cut from the crystals grown revealed that the degree of nonuniformity of the distribution of boron in the crystals depended strongly on the crystallization rate. The maximum nonuniformity was observed when the rate reached 5.8×10^{-3} cm/s, with the boron concentration in the upper part of the crystal being about 13 times that in the lower part of the crystal. Figures 2; references 5 (Russian).

Analysis of the Results of Research on the Liquation of Components in Doped Germanium Crystals Produced by the Method of Directed Crystallization Under Zero Gravity and Ground Conditions

917M0039I Moscow FIZIKA I KHIMIYA
OBRABOTKI MATERIALOV in Russian No 6,
Nov-Dec 90 (manuscript received 12 Jan 90) pp 71-75

[Article by I.N. Belokurova, V.S. Zemskov, and D.M. Khavzhu, Moscow]

UDC 548.55.519.6

[Abstract] A mathematical model of the distribution of components in the cross sections of crystals grown under a stationary mode of normal directed crystallization in the presence of a laminar single-vortex flow of melt before the crystallization front has been formulated elsewhere. The authors of the present article compare the results of mathematical modeling with the results of experiments on directed crystallization of doped germanium crystals under zero-gravity conditions and under ground conditions. They compare results obtained by using previously developed expressions to determine the maximum concentration nonuniformity in the cross sections of crystals and the cross section of the distribution of the dopant in a doped crystal with the results of in-flight experiments conducted on board the Kosmos-1645 and Kosmos-1744 artificial earth satellites and with the results of ground experiments that have been described elsewhere. The comparison presented shows that, overall, the proposed model of crystallization that has been published elsewhere (i.e., $A = R^2HK/DV_0$, where R is the crystallization rate, H is the crystal diameter, K is the equilibrium coefficient of the component distribution, D is the coefficient of the component's diffusion in the melt, and V_0 is the characteristic velocity of the melt along the crystallization front) provides an accurate reflection of the existing laws governing the distribution of components in the cross sections of crystals grown during normal directed crystallization. Because the calculated and experiment results do not completely coincide, however, the proposed mathematical model can only be characterized as being semiquantitative. Figures 5; references 9 (Russian).

Modifying Carbon Fibers in a Pulsed High-Enthalpy Flow

917M0039J Moscow FIZIKA I KHIMIYA
OBRABOTKI MATERIALOV in Russian No 6,
Nov-Dec 90 (manuscript received 26 Dec 89) pp 76-79

[Article by A.O. Ostapovich, I.V. Blinkov, and K.V. Ivanov, Moscow]

UDC 538.971+539.61

[Abstract] The trend in producing carbon fiber-based composites has been to use an approach based on developing methods of modifying the surface of the carbon fibers so as to improve the adhesion of the compound with the matrix. In a number of cases, however, the improvement in the adhesion of the fiber and matrix has resulted in a worsening of the strength characteristics of the fiber itself. More recently, a number of methods of modifying carbon fibers have been proposed to simultaneously improve their cohesion to the matrix and increase the level of the composite's strength. These methods entail two types of changes in the carbon fiber during processing, i.e., changes in the surface relief of the carbon fiber and changes in the chemical state of the carbon fiber's surface (the latter includes qualitative and quantitative changes in the make-up of the functional groups grafted to the fiber and changes in the chemical structure of the surface of the carbon fiber itself during the modifying treatment). The authors of the study reported herein examined the process of modifying Ural N-24 carbon fiber in a high-voltage capacitive discharge in an atmosphere of argon or hydrogen. The energy of a single discharge lasting 10^{-4} to 10^{-5} seconds ranged from 25 to 40 J. The filament was pulled through the discharge zone at a rate ensuring that the pulsed discharge would act on each unit of the fiber braid's surface five or six times. Topographic changes in the fiber's surface relief during the course of the modifying treatment were determined by using scanning and transmission electron microscopy. To obtain a quantitative estimate of the change in the surface relief of the fibers, the Brunauer, Emmett, and Teller [BET] method was used to measure the area of the fibers' specific surface. Regardless of whether the treatment was performed in an argon or hydrogen atmosphere, etching craters appeared in the fibers following treatment. Treating the carbon fibers in a pulsed capacitive discharge resulted in a 30-40% increase in their surface energy, primarily on account of an increase in the polar component of the surface energy. The topography of the fibers was indeed changed during the modification procedure tested; this change resulted in an increase in the carbon fibers' specific surface area. Figure 1, tables 2; references 9: 1 Russian, 8 Western.

The Structure, Properties, and Use of Al_2O_3 -Based Powders Produced by Cryochemical Technology

917M0039K Moscow FIZIKA I KHIMIYA
OBRABOTKI MATERIALOV in Russian No 6,
Nov-Dec 90 (manuscript received 13 Sep 89) pp 119-123

[Article by A.A. Mikhaylenko and G.A. Fomina, Kiev and Moscow]

UDC 621.762.01:546-31

[Abstract] Ceramics with specified electrical, chemical, and mechanical properties are widely used in the electronics industry. Because these properties depend primarily on the microstructure of the given material, many conventional methods cannot provide the strictly controlled particle sizes and make-ups required to produce such specific properties. A cryochemical technology is currently being developed that is proving to be a simple way of producing ultrafine particles that can then be easily subjected to additional treatment such as reduction or annealing. The authors of the study reported herein use this cryochemical technology to develop Al_2O_3 -based powders. The used pure-grade aluminum sulfate crystal hydrate, i.e., $Al_2(SO_4)_3 \times 18H_2O$. A solution with an 80% concentration was dispersed into liquid nitrogen by an air-atomizing burner. The resultant cryo-granules (size, 400-800 μm) were subjected to sublimation drying in an LZ-92 unit. Unlike in the procedure described elsewhere, the cryo-granules were subjected to an additional stage of vacuum drying for 2 hours at 350°C. The powders prepared by using the new technique were stronger than those prepared by using the standard procedure and were deemed suitable for use in manufacturing fine ceramic bases to serve as activating additives for producing technical-grade ceramics in the electronics industry as well as for raising various surfaces to a higher purity class. Figures 5, tables 2; references 7: 3 Russian, 4 Western.

Spectral and Temperature Features of the Energy Distribution of Oxygen Desorbed From a $YBa_2Cu_3O_{7-x}$ Crystal by Laser Radiation in the Region of Superconductive Transition

917M0040A Moscow POVERKHNOST: FIZIKA,
KHIMIYA, MEKhanika in Russian No 12, Dec 90
(manuscript received 18 Sep 89; signed to press
19 Jan 90) pp 17-22

[Article by I.F. Moiseyenko, A.A. Lisachenko, S.V. Moshkin, and M.A. Kuzmina, Physics Research Institute, Leningrad State University]

UDC 537.534

[Abstract] In the past few years time-of-flight spectroscopy of the primary products of laser desorption has become popular in both investigating the mechanism of the interaction of laser radiation with the surface of a solid and analyzing surface states and absorption layers. The parameters of time-of-flight spectra yield information regarding the make-up and amount of desorbed particles, the kinetic energy distribution of desorption products, the strength of their bonds to surfaces, and the resistance of surfaces to laser effects. This article reports on the use of the time-of-flight spectroscopy method to study high-temperature superconductive materials and to determine the effect of a superconductive transition on the energy distribution of desorbed particles. $YBa_2Cu_3O_{7-x}$ monocrystals with dimensions of 3 x 3 and

3 x 4 mm² were secured to a holder made of gold foil and placed in the chamber of a mass spectrometer (described elsewhere). A vacuum of $P \approx 10^{-10}$ torr was created, after which desorption was initiated by radiation from the harmonics of a pulse (10 ns) neodymium laser ($\lambda = 1,064, 532, 354, \text{ and } 266 \text{ nm}$) that was focused on the specimens. The time-of-flight mass spectrometer used (which had an automatic recording system) made it possible to measure the intensity of four desorbed components with a period of 10 μs from a single laser flash. The experiments were performed in the temperature interval from 77 to 330 K. Several qualitative conclusions were drawn regarding the possible mechanisms of selected stages of the chain of processes including the absorption of light quanta and the excitation of the desorbed particles. It was discovered, for example, that the desorption of oxygen from high-temperature superconductors and that from oxides do not have much in common. When the thresholds of oxygen desorption at different wavelengths were compared, a monotonic increase in the threshold power density from 1.5 to 16.0 MW/cm² was found to occur as the wavelength was increased from 266 to 532 nm, and at 1,064 nm desorption of "slow" molecular oxygen was recorded at 3.5 MW/cm². It was hypothesized that that mechanism of desorption of oxygen from an oxide that is termed high-temperature superconduction is caused by the primary stages of the process, i.e., by the mechanisms of light absorption and the excitation of the object. No changes in specimens' spectral characteristics were observed upon the transition to a superconductive state. The experiment results confirmed the fundamental possibility of investigating the mechanisms of the excitation of oxygen structures connected with the high-temperature superconduction state of YBa₂Cu₃O_{7-x} specimens. Figures 3; references 6: 4 Russian, 2 Western.

Critical Phenomena in Surface Layers; Correlation Function and Correlation Radius

917M0040B Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 12, Dec 90 (manuscript received 9 Jan 89; signed to press 10 Oct 90) pp 22-27

[Article by L.G. Grechko, A.V. Chalyy, and L.M. Chernenko, Institute of Surface Chemistry, UkSSR Academy of Sciences, Kiev, and Medical Institute imeni A.A. Bogomolets, Kiev]

UDC 532

[Abstract] Investigating the phase transformations and critical phenomena occurring in surface layers and transition regions (i.e., interfaces) requires that specific consideration be given to such actual factors as the spatial boundedness of the system under investigation. The goal of the study reported herein was to present a theoretical description of the correlation properties of such spatially bounded systems as surface layers and interfaces and

biomembranes and synaptic gaps; this description considers the second-order phase transitions or critical phenomena that are isomorphic for these phenomena. The authors derive and analyze expressions for the pair correlation function, i.e., $G_2(r)$, and correlation radius, i.e., R_c , of the order parameter in a surface layer (this parameter remains finite even at the very point of the transition under investigation). They use the expressions derived to study the dependence of the correlation radius on the thermodynamic variables and geometric dimensions of a layer for single-component and binary systems. The expressions derived may be used to determine the correlation properties of matter in a spatially bounded surface layer filled with a substance that is close to being in a phase transition. These properties should in turn find direct manifestation in the specific behavior of various equilibrium and kinetic physicochemical properties of matter located in a surface layer in the region of a phase transition. Tables 2; references 7 (Russian).

Effect of Si on a Ba-W Film System

917M0040C Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 12, Dec 90 (manuscript received 22 Mar 89; signed to press 22 Nov 89) pp 52-56

[Article by Yu.V. Zubenko, Leningrad State University]

UDC 537.533.2

[Abstract] The authors of the study reported herein used a field-emission microscope to study the absorption of barium on tungsten coated with a silicon film. A tungsten spiral was used to vaporize the silicon, and a barium beryllate getter served as the barium source. Both sources were mounted in one instrument and placed at the side of the pivot. The adsorbate was condensed onto the spike (which was at room temperature) from the side of the source. The adatoms were distributed along the emitting surface of the pivot-pole by establishing a migration equilibrium at a base temperature of about 700 K in the case of Si and 600 K in the case of Ba. The equilibrium was considered steady if protracted heating of the base did not result in any additional change in the field-emission current. It was discovered that applying a layer (of approximately monatomic thickness) of silicon to a tungsten base resulted in a valence saturation in the near-surface layer that in turn resulted in a significant change in the nature of Ba absorption and a reduction in the desorption heat. Figures 4; references 8: 7 Russian, 1 Western.

Physicochemical State of the Surface of the Alloy VT18U After the Action of a High-Power Ion Beam

917M0040D Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 12, Dec 90 (manuscript received 10 Jan 89; signed to press 27 Apr 89) pp 79-84

[Article by A.D. Pogrebnyak, G.Ye. Remnev, V.A. Shulov, A.E. Strygin, Yu.D. Yagodkin, and Yu.B. Alekseyev, Moscow Aviation Institute]

UDC 539.213.621.17.533

[Abstract] Ion beam bombardment of the surface layers of construction materials is one of the most promising methods of increasing the service performance of machinery components. Making purposeful changes in the components' service performance requires that specific consideration be given to the physicochemical state of that component's surface layer regardless of the treatment used. In view of this, the authors of the study reported herein investigated the effect of ion beam bombardment on the physicochemical state of the surface layers of the alloy VT18U. During the course of their research they subjected $150 \times 15 \times 5 \text{ mm}^3$ specimens of the alloy VT18U to Auger electronic spectroscopy, exoelectron emission, and x-ray analysis. They also measured the specimens' microhardness and roughness. It was discovered that a high-power nanosecond beam of C^+ and H^+ ions could indeed be used to modify the chemical make-up and structural-phase state of the surface layers of the alloy VT18U. Specifically, as the density of the ion current is increased, the content of impurities in a surface layer about 300 nm thick first increases ($10\text{--}40 \text{ A/cm}^2$) and then decreases, remaining at a higher level than in their initial state. X-ray crystallography studies indicated that ion beam bombardment not only changes the chemical make-up of thin surface layers but also modifies the treated specimen's structural-phase state, with the region of structural variations extending much deeper than the zone of "chemical mixing." The changes established during the research were attributed to two processes: (1) the formation of a plasma cloud over the surface of the material in which such processes as ionization, recombination, diffusion, oxidation, and complexing occur and (2) the occurrence of rapid heating and cooling in the near-surface region of the material, which has the effect of shockwaves on the alloy's crystalline lattice. Figures 3; references 9: 6 Russian, 3 Western.

Features of Defect Formation During Recrystallization of Monocrystalline Silicon by Pulsed Laser Radiation of Millisecond Duration

917M0040E Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 12, Dec 90 (manuscript received 25 Apr 89; signed to press 28 Aug 89) pp 97-103

[Article by A.V. Demchuk, N.M. Kazyuchits, and V.A. Labunov, Minsk Radio Engineering Institute]

UDC 621.315.592

[Abstract] Despite the fact that the processes of defect formation in semiconductors under the effect of pulsed radiation of millisecond duration is very interesting from both a scientific and applications standpoint, sufficient research on the problem is still lacking. The authors of study reported herein examined the distinctive features of defect formation in monocrystalline silicon as it is fused under the effect of millisecond-range

pulsed laser radiation during the various stages of fusion and modification of the silicon's surface morphology. They discovered that during the recrystallization of monocrystalline silicon by such radiation, significant thermomechanical stresses are generated in the silicon's structure. These stresses lead to plastic deformation of the material and activation of the (100) and (110) glide systems. During this plastic deformation dislocations are formed that in turn result in the formation of liquid-phase nucleation centers in the initial stages of the development of surface fusion. The density and structure of defects in liquid phase-recrystallized and plastically deformed regions differ greatly from one another, which makes it possible to identify these regions during processing in structure-sensitive etching agent. Figures 4; references 4 (Russian).

Formation of an Altered Layer on a Silicon Surface in the Oxygen Plasma of a Radio-Frequency Discharge

917M0040F Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 12, Dec 90 (manuscript received 3 Feb 89; signed to press 26 Oct 89) pp 104-109

[Article by A. Grigonis, L. Pranyazichyus, V. Kulikauskas, and G. Balchaytis, Kaunas Polytechnic Institute]

UDC 537.534

[Abstract] Many researchers have examined the low-temperature oxidation of silicon in oxygen plasma. Despite the promise of this method in producing dielectric layers on an Si surface, however, it has not found wide-scale practical application. This is largely because of the complexity of the physicochemical processes occurring in the surface layers of the Si under the conditions of its processing in the oxygen plasma of a radio-frequency discharge. The authors of the study reported herein examine the changes occurring in an Si layer that result from the effect of radio-frequency oxygen plasma. They subjected specimens of Si with an electronic conduction having a specific resistance of $4.5 (\Omega \times \text{cm})$ and with orientation in the plane (111). The radio-frequency oxygen plasma was excited in a diode asymmetric system, the ion-accelerating potential of the self-bias ranged from 300 to 1,500 V, and the specific power of the discharge ranged from -1 to -1.5 W/cm^2 . The gas pressure in the working chamber was kept at 10 Pa, and the specimens' temperature amounted to $150 \pm 20^\circ$. On the basis of their experiments, they propose a physical model of SiO_x layer formation on silicon in oxygen plasma. This based on the principle that mixing of atoms takes place during simultaneous desorption and sputtering. The experiments performed indicate that during the process of the effect of oxygen radio-frequency plasma, the silicon surface is covered with an SiO_2 film under which an unsaturated oxide consisting of a mixture of Si and SiO_2 lies. Dielectric regions that include an SiO_x (where $0 \leq x \leq 2$) in their make-up are

shown to form at the oxide-silicon interface. Figures 6, table 1; references 6: 2 Russian, 4 Western.

Increasing the Effectiveness of Photoetching Polymers by Sliding a Gas Discharge Along the Dielectric Surface

917M0040G Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 12, Dec 90 (manuscript received 27 Mar 89; signed to press 28 Aug 89) pp 153-155

[Article by L.V. Velikov, S.I. Dolgayev, S.D. Dushenkov, I.O. Kovalev, and G.P. Kuzmin, Physical Technology Institute, USSR Academy of Sciences, Moscow]

UDC 541.141.8

[Abstract] The effect of photoetching polymers under the effect of vacuum ultraviolet radiation [VUV] ($\lambda = 115$ to 200 nm) in an oxygen-containing medium may be used

for certain processes in microelectronics. The possibility of using this photochemical process in microelectronics has spawned the search for suitable VUV radiation sources. The authors of the study reported herein worked to determine those parameters of gliding a gas discharge along a dielectric surface that would have the greatest impact on increasing the effectiveness of photoetching and increasing the rate of photoetching polymer materials when such a source is used. The following four parameters that may have an effect on the rate at which polymers are photoetched were considered: the medium in which the charge is triggered, the charge repetition frequency, the type of dielectric used, and amplitude of the high-voltage pulse, and the gas pressure. The experiments conducted demonstrated that the photoetching rate increases as the high-voltage pulse amplitude and gas pressure increase. It was further discovered that radiation with a wavelength between 125 and 180 nm makes a major contribution to the rate of polymer photoetching by means of the gas discharge from a VUV radiation source. Figures 2; references 4 (Russian).

Synthetic Liquid Fuel From Brown Coals of the Kansk-Achinsk Basin

917M0041A Moscow KHIMIYA TVERDOGO
TOPLIVA in Russian No 6, Nov-Dec 90 (manuscript
received 1 Aug 90) pp 55-63

[Article by M.K. Yulin, Mineral Fuels Institute]

UDC 662.74:552

[Abstract] The different types of transportation that require liquid engine fuel are primarily responsible for the ever-increasing demand for liquid engine fuel. Expansion of the production of all types of engine fuels is largely being held back by the relatively limited reserves of oil, which is the conventional raw material for such fuels. One promising raw material for producing synthetic liquid fuel is coal. The brown coals of the Kansk-Achinsk Basin, which meet the requirements regarding refinement into liquid fuel, are being examined as a prospective raw material base in view of their great abundance (600 billion metric tons) and the relatively low costs of recovering them. Back in the 1970's a set of research projects aimed at improving existing technologies for turning coal into synthetic liquid fuel was conducted. Among other things, this research focused on the problem of rarefying the coal, i.e., optimizing the reactions entailed in the transfer of hydrogen from the donor/paste-forming agent to the coal. This article describes a promising technology that has been developed to produce synthetic liquid fuels from coal by direct hydrogenation of hydrogen under low pressure. It is shown that the process may be implemented by using donor hydrogen of coal origin, active regeneratable catalysts, and organic additives. A kinetic model of the hydrogenation of coal along with diagrams of the process of hydrogenating coal into synthetic liquid fuel and a diagram of the process of refining the slime are provided along with tables summarizing the results of hydrogenating brown coals from different beds and the results of using various catalysts during the proposed coal conversion technology. Included among the catalysts examined are catalysts combining Mo and Fe^{+3} and Mo and S; heterogeneous Al-Ni-Mo, Al-Co-Mo, and Co-Mo catalysts; and finely dispersed $WS_2 + Co$ and $MoS_2 + WS_2$ catalysts. Data showing that the improvement in coal hydrogenation indicators that is achieved by adding anthracene and lignin as organic additives are also presented along with tables summarizing the characteristics of liquid products of the hydrogenation of brown coal and the material balance of the hydrogen of brown coal from the Borodino deposit. Figures 4, tables 4; references 21 (Russian).

Using Zeolite-Containing Ni-Mo Catalysts in the Hydrocracking of Coal Rarefaction Products

917M0041B Moscow KHIMIYA TVERDOGO
TOPLIVA in Russian No 6, Nov-Dec 90 (manuscript
received 21 Mar 90) pp 71-75

[Article by A.S. Maloletnev, L.P. Alekseyenko, A.A. Krichko, R.A. Konyashina, and L.N. Lebedeva, Mineral Fuels Institute and All-Union Petroleum Refining Research Institute]

UDC 662.74:552

[Abstract] The effectiveness of hydrocracking and its competitiveness with other processes for refining vacuum distillates of petroleum and coal origin are largely determined by correct selection of catalysts and the technology used to produce one product or another. The following properties of zeolite catalysts make them especially useful in the hydrogenation refining of coal rarefaction products: the presence in them of strongly acid centers on a developed surface, the molecular sieve nature of their structure (which facilitates selectivity of transformations), and the highly dispersed distribution of metals in metal-zeolite specimens. In addition, the ion exchange properties of zeolites makes it possible to prepare catalysts by ion exchange methods, which permits directed catalyst selection. The authors of the study reported herein examined the catalytic activity of zeolite-containing Al-Ni-Mo catalysts synthesized at the All-Union Petroleum Refining Research Institute during light single-stage hydrocracking of hydrofined coal distillates with a boiling point from 350 to 520°C. It was discovered that the degree of transformation of raw material per pass ranges from 32 to 35% in the presence of a catalyst containing 16% MoO_3 and 6.0% NiO under comparatively soft conditions (6 MPa, 380°C). From the standpoint of their physicochemical and performance characteristics, the gasoline and diesel fuel obtained during hydrocracking were analogous to petroleum fuels. The gasoline obtained during hydrocracking is virtually sulfur free ($<0.01\%$), and it has an aromatic hydrocarbon content of 47.4% and octane number of 80.9 (based on the motor method versus 84.6 based on the researchers' method). The hydrocracking-produced gasoline has a boiling point up to 180°C and may be used as a component of high-octane gasoline or as a raw material for catalytic reforming. From the standpoint of their physicochemical and performance properties those products with boiling points of 180 to 360°C fully meet the requirements stipulated in All-Union State Standard 305-82 for grade L diesel fuel. Figure 1, tables 3; references 7 (Russian).

Two-Stage Underground Gasification of Coals

917M0041C Moscow KHIMIYA TVERDOGO
TOPLIVA in Russian No 6, Nov-Dec 90 (manuscript
received 13 Mar 90) pp 76-79

[Article by Ye.V. Kreynin, Mining Institute imeni A.A. Skochinskiy]

UDC 66.0943

[Abstract] The main shortcomings of the conventional underground coal gasification technology are the large losses of heat to the rock mass surrounding the underground gas generator and the significant heat losses to the air blower during gas formation and implementation of the underground coal gasification. As a result of these losses, only 55-65% of the chemical energy of coal goes to the gas produced. The authors of the study reported

examined the prospect of increasing the efficiency of underground coal gasification by implementing it in two stages. Ideally, the first stage in the proposed two-stage process is reduced to two reactions with opposite thermal effects, i.e., $2C + O_2 = 2CO + 246.62 \text{ MJ}$ and $C + H_2O = CO + H_2 - 118.91 \text{ MJ}$. The second stage of the process is based on steam blowing. The chemism of the second stage of the gasification process is determined by the decomposition of superheated steam forced into the reaction zone of the underground gas generator by the heat accumulated in the first stage of gasification. Calculations performed during the research demonstrated that two-stage underground gasification increases the process' efficiency from 55-65 to 80-85%. Table 1; reference 1 (Russian).

Effect of Different Factors on Cohesion Bonding of Thermally Destroyed Grains of Sintered Coals

917M0041D Moscow KHIMIYA TVERDOGO
TOPLIVA in Russian No 6, Nov-Dec 90 (manuscript
received 5 Oct 89) pp 86-90

[Article by Yu.V. Biryukov, P.D. Golovin, I.D. Drozd-nik, L.V. Isayenko, R.T. Latypov, V.K. Malevich, A.S. Polyanskaya, M.G. Sklyar, and Ye.N. Stepanov, Kharkov Polytechnic Institute]

UDC 662.74

[Abstract] Introducing a metal core heated to a specified temperature (700-900°C) into pulverized sintered coal results in the formation of thermal destruction products possessing the property of binding contiguous coal grains. The layer of destroyed coal directly adjacent to the rod's surface binds with the rod's surface by adhesion reaction forces, and the subsequent layers of destroyed grains bind with one another by cohesion reaction forces. The thickness (and consequently the mass) of the coked residue of thermally destroyed coal meshed with the rod will depend on the coals' sinterability. The authors of the study reported herein investigated the cohesion binding of thermally destroyed coal grains of sintered coals by the method of coking them to a heated rod. Specifically, they studied the effect of the time for which the rod is held in the coal and the granulometric and petrographic make-ups of the coals on the amount of coke formed. It was discovered that the rate of the process of the cohesion binding of the coal grains reached a maximum in the case of types G and Zh sintered coals and reached a minimum in the case of types K and OS coals. In the metamorphism series for well-sintered coals (types Zh and K), the temperature of the initial of cohesion binding was higher than for gas coal; type OS coal occupied an intermediate position with respect to this indicator. Reducing the grain size (from 3-0 to 1-0 mm) of gas coal was found to reduce the amount of coke formed on the rod, whereas the effect of this type of change in grain size in coking appeared to be little significant. An increase in the amount of coke formed on

the rod was observed in the case of type OS coal, however. Tables 6; references 9: 8 Russian, 1 Western.

Fractal Structures During Carbonization of Petroleum Raw Material

917M0041E Moscow KHIMIYA TVERDOGO
TOPLIVA in Russian No 6, Nov-Dec 90 (manuscript
received 28 Feb 89) pp 91-94

[Article by I.R. Kuzeyev, I.Z. Mukhametzyanov, and Yu.M. Abyzgildin, Ufa Petroleum Institute]

UDC 665.642:529.2

[Abstract] During the process of carbonization of petroleum residues there is an irreversible increase in asphalt- enes in the system of supermolecular formations. In the past few years fractal theory has been widely used in studying various physical phenomena (including coagu- lation, polymer formation, and percolation). The use of the fractal approach has been largely connected with the fact that the given phenomena and processes entail a nonequilibrium growth that results in the formation of fractal structures. The authors of the study reported herein used the fractal approach to study the growth mechanism of asphaltenes during the carbonization of petroleum raw material. In a computer experiment based on a cluster-cluster association model they studied the effect of the initial concentration and formation rate of particles in the system on the mean specific density of the clusters. (They define mean specific density as the ratio of the number of occupied cells to the total number of cells in the minimum rectangle bounding a cluster.) It was discovered that large clusters are not dependent on the fractal dimensionality of these factors. Denser clusters were found to form as the initial concentration of particles in the system increased. The rate at which particles formed in the system was found to determine the structure of the clusters, and the specific density of the clusters formed for different-size local volumes was found to coincide within the bounds of the mean statisti- cal error. The computer experiment conducted thus demonstrated that processes of irreversible growth in the initial stages of carbonization may indeed have a signif- icant effect on the course of some total process or phenomenon. The results obtained qualitatively charac- terize the effect of selection of the raw material and the effect of the conditions under which the process is conducted on the structural properties of the product in the early stages of carbonization (specifically, on the properties of petroleum pitch). Describing the mecha- nism of liquid-phase structuration within the framework of the growth of fractal structures together with the generally accepted mechanism of carbonization makes it possible to use the method of simulation as one possible way of describing the transition from the micro- to macrolevel. Figures 3; references 5: 3 Russian, 2 Western.

The Effect of the Surface Layer of Artificial Graphite on Its Reactivity

917M0041F Moscow KHIMIYA TVERDOGO
TOPLIVA in Russian No 6, Nov-Dec 90 (manuscript
received 27 Oct 89) pp 95-98

[Article by G.D. Apalkova, V.P. Balykin, A.Ya. Vesnin,
and S.I. Kuzmina, GosNIIEP]

UDC 621.3.035

[Abstract] One of the most important characteristics of graphitized electrodes is their reactivity with respect to the oxygen of air, which limits their consumption on account of oxidation under conditions of the elevated temperatures of arc steel-melting furnaces. The authors of the study reported herein examined the effect of removing the surface layer of graphite on the reactivity and energy state of the surface of a graphitized electrode. The methods of thermogravimetric analysis, calorimetric determination of wetting heat, and scanning electron microscopy were used to study the effect of the surface layer of artificial graphite formed during the process of graphitization of carbon material on its reactivity. It was discovered that the surface layer of artificial graphite has a protective effect. It was hypothesized that this protective effect may be a consequence of the fact that, during graphitization, the surface free bonds (active centers) become involved in the three-dimensional ordering of the carbon, which is the essence of the graphitization process. The participation of the surface active centers in the restructuring of the carbon is a type of blocking of the centers that facilitates a reduction in the graphite surface's reactivity. Removal of the surface layer by machining is accompanied by the release of the carbon's active centers, which helps increase its reactivity. Analogously, an inner surface of cleavage cracks is formed after completion of the graphite's restructuring as it cools; this stage also entails the release of the active centers. In the presence of an inert surface layer, the active nature of the inner surfaces of these cracks results in their selective oxidation. The selective nature of this oxidation of the artificial graphite on account of the nonuniform energy of its surface was also demonstrated. Finally, the energy state of the graphite's surface was found to be determined by the conditions of its formation during the multistage process of its production and found to be controllable within broad limits without introducing additional production techniques. Figures 4; references 4 (Russian).

Effect of the Structure of Calcined Carbon Filler on the Oxidation of Electrode Graphite

917M0041G Moscow KHIMIYA TVERDOGO
TOPLIVA in Russian No 6, Nov-Dec 90 (manuscript
received 27 Jul 88) pp 99-103

[Article by V.P. Balykin and N.M. Umrilova, GosNIIEP]

UDC 774.332:231

[Abstract] A great many works have examined the processes of the reaction of carbon composites with gaseous oxidizing agents; however, the oxidation mechanism has not been fully clarified. Consequently, the authors of the study reported herein examined the electrode graphite at 600°C. During their studies they used the methods of thermogravimetric analysis, porosity determination, and scanning electron microscopy to study graphitized materials based on a mixture of cokes with a needle structure and materials based on the coke KZ-8. The latter was found have a much higher reactivity (3.73% versus 1.50%). Also demonstrated was the effect of the structure of finely dispersed fractions of filler on the formation of a binder film and on the reactivity of the graphitized material. They proposed a schematic model of the process of the oxidation of carbon material that specifies the sequence of the reaction of the phases with different structures and reaction surfaces. In the initial stage of oxidation (to a mass loss of about 1.0-1.5%) the binder phase that covers the surface of those particles of filler that are accessible to the effect of the oxidizing agent and that is adjacent to the surface of the open pores burns up. The filler particles are oxidized next. From that point on the mass of the material decreases on account of the simultaneous oxidation of the binder and filler. Since the surface of finely dispersed filler fractions predominates in the material's total reaction surface, the loss of mass by the filler phase occurs on account of oxidation of its fine particles. In this stage it is mainly the finely dispersed filler fractions and binder phase (paste) that burn. This stage of oxidation continues until the material has lost about 4-5% of its mass. Next the open porosity and, consequently, the material's reaction surface increase. The fraction of mass loss caused by the burn-up of the filler's large grains increases. The material then loses mass on account of oxidation of the binder and large and finely dispersed fractions of the filler. In the initial and subsequent stages of the oxidation the total burn-up rate is determined by the nature of the filler's structure, primarily by its finely dispersed fractions, which have a definite effect on the formation of binder film in the composite. Figures 4, table 1; references 9: 7 Russian, 2 Western.

The Effect of the Conditions of the Thermochemical Treatment of Natural Graphite on Its Crystalline Structure and Electrophysical Properties

917M0041H Moscow KHIMIYA TVERDOGO
TOPLIVA in Russian No 6, Nov-Dec 90 (manuscript
received 14 Jul 89) pp 104-108

[Article by I.D. Buraya, L.L. Vovchenko, L.L. Voznaya, Yu.I. Sementsov, I.G. Chernysh, and O.P. Yatsyuk, Surface Chemistry Institute, UkSSR Academy of Sciences]

UDC 548.736

[Abstract] Thermally expanded graphite is a new disperse carbon material with a developed surface and a crystalline structure that is close to that of graphite. Thanks to its high pressability, comparatively high electric and heat conduction, and high gas permeability in the direction of the pressing axis, thermally expanded graphite holds extensive promise with respect to producing carbon composites with a range of controllable properties. The literature does not yet contain any systematic research on the effect of the quality of the initial graphite raw material, method of producing thermally expanded graphite, or method of compacting it on the nature and extent of the temperature dependence of the specific electric resistance and thermoelectromotive force of compact specimens of thermally expanded graphite. For their initial raw material, the researchers chose different grades of disperse graphite from the Zavalye deposit. They oxidized the initial graphite by using the biochromate and persulfate methods to produce a graphite bisulfate and two graphite mixtures. The specimens were rinsed until they achieved the pH level of the rinse waters, placed in a reactor, and heated to the respective expansion temperature. The different powders were heat-treated at an expansion temperature of 400°C for 10 minutes or at expansion temperatures of 800 and 1,000°C for 0.5 minutes and then annealed at 550°C for 30 minutes. The thermally expanded graphite powders were then compacted by the method of cold pressing under a pressure of 78.4 MPa; all of the resultant compact specimens had a density of 1.6-1.7 g/cm³. It was discovered that the method used to oxidize the graphite did not affect the nature of the dispersion process. Specific electrical resistance was not found to depend on the size, form, or specific surface of the thermally expanded graphite particles because the vermicular structure of the thermally expanded graphite's particles is destroyed as soon as the pressure reaches 0.49 MPa. The different specimens had different sulfur contents. Using potassium bichromate as an oxidizing agent (as opposed to using ammonium persulfate) was found to increase the concentration of residual sulfur compounds, whereas additional heat treatment reduced it. Additional heat treatment had virtually no effect on the specific surface of the thermally expanded graphite powder, which confirms the previous hypothesis of the absence of any effect by the specific surface on the

specific electrical resistance. It was hypothesized that the residual sulfur compounds act as an acceptor and result in a shift in the equality of the concentrations of electrons and holes characteristic for natural graphite and in an increase in the total concentration of current carriers. Thus, in the low-temperature range, the extent and nature of the specific electric resistance of the test specimens of compact thermally expanded graphite powders were indeed found to depend on the conditions under which the thermally expanded graphite is produced and to be determined primarily by the concentration of residual intercalation compound. Figures 2, tables 3; references 11: 7 Russian, 4 Western.

Use of Associations of Microorganisms for Purification of Waste Water From Postfermentation Mash

917M0042a Moscow GIDROLIZNAYA I
LESOKHIMICHESKAYA PROMYSHLENNOST in
Russian No 8, Nov-Dec 1990, pp 1-3

[Article by O. A. Zentsova, L. V. Sokolova, N. I. Isaykina, and N. V. Bobrova, SKF [expansion not given] All Union Scientific Research Institute for Protein Synthesis]

UDC 630*836.1:628.35

[Abstract] The choice of microorganisms with elevated biodestructive activity, capable of decomposing the difficult to oxidize organic substances found in postfermentation mash was studied. The microorganisms were isolated from the mash channel of the Krasnodarskiy Chemical Combine Yeast Factory and from its purification installation, as well as from municipal active sludge and from the ANKUM-2M fermenter which has been adapted to mash purification. Fifteen cultures were obtained from the factory samples, which exhibited stable growth on mash for 20 generations. The degree of purification produced by these cultures ranged from 7% to 31%. Associates of microorganisms were formed using the principle of selection from one ecological niche. Variable results were obtained, due in part to mash inhomogeneity. The most active associate achieved a purification level of about 35%. This associate reduced mash chemical oxygen demand by 50-54%. When this associate was used to enrich active sludge, 60-70% purification was achieved. Selection for growth rate and decomposition of organic substances was then used to isolate a natural associate from active sludge. The associate contained 96 strains of *Pseudomonas*, *Zoogloae*, *Micrococcus*, *Flavobacterium*, and *Alcaligenes*. The natural associate produced 60-76% purification in 7-10 days, which would require 30-40 days with conventional active sludge. Figures 1; references 7: 5 Russian, 2 Western.

Reduction of Gas Discharge During Unloading of Lignin from Hydrolysis Apparatus

917M0042b Moscow GIDROLIZNAYA I
LESOKHIMICHESKAYA PROMYSHLENNOST
in Russian No 8, Nov-Dec 1990, p 3

[Article by I. I. Korolkov]

UDC 630*813.11:331.103.6

[Abstract] The low temperature water removal method for lignin discharge from hydrolysis apparatus does not address the problem of removing the lignin from the pulp obtained. It would be more efficient to improve the water washing of the lignin in the apparatus, so that less harmful gas levels are obtained when the lignin is removed. Calculations show that for 5000 kg of initial woody stock and a final furfural concentration in the lignin liquid of 0.01%, 0.31 kg of harmful furfural will be released into the surrounding environment when the lignin is discharged from the hydrolysis apparatus. Washing the lignin with water at 180-185, using a volume around 10-15% of the hydrolysate to be washed, is more practical. The previous digestion must have been conducted so that the level of liquid in the hydrolysate, before introduction of the water, is lowered to the upper level of the lignin in the apparatus. For a hydrolysis apparatus of 50 m³ volume, containing 1.75 tons of lignin, the amount of liquid after hydrolysis will be 3.5 m³. In this case it is necessary to use 10.5 m³ of water in order to reduce the furfural level by a factor of three. This procedure also reduces the loss of sugar remaining in the lignin and improves the quality of the lignin obtained for further processing.

Fire Explosion Hazard Index, Thermal and Electrophysical Properties of Certain Wood Chemical Products

917M0042c Moscow GIDROLIZNAYA I
LESOKHIMICHESKAYA PROMYSHLENNOST
in Russian No 8, Nov-Dec 1990, pp 5-7

[Article by Ye. V. Yelizova, N. I. Lapshina, and V. V. Abramova, Central Scientific Research and Planning Institute of the Wood-Chemistry Industry]

UDC 630*86.004.12

[Abstract] Various previously unreported properties related to the flammability of wood-chemistry products are tabulated, including the flash point, ignition point, and autoignition point of 22 substances; the density at 20, 40, 60, 80, and 100, the kinematic viscosity at these temperatures, the thermal conductivity at 20, and the specific heat of 18 substances; and the specific volume electrical conductivity at 110 and the specific resistance at the listed temperatures for 5 substances. The data presented may be used for quantitative evaluation of the

explosive hazard of technological products and for developing technological rules, standards and preventive measures. References 5: Russian.

Disintegration—Method for Increasing Feed Value of Microbial Biomass

917M0042d Moscow GIDROLIZNAYA I
LESOKHIMICHESKAYA PROMYSHLENNOST
in Russian No 8, Nov-Dec 1990, pp 11-12

[Article by V. A. Popova, A. M. Shaposhnikov, G. M. Petrushko, Kh. V. Voyt, B. V. Loopere, I. A. Yegorov, L. Ya. Kupina, S. Kh. Pebre, L. Ya. Galanina, and S. V. Kozlova]

UDC 636.085.15

[Abstract] The role of cell disintegration in increasing the availability of yeast protein was studied. The yeast cells were either treated with a shock activation disintegrator after separation from the culture, or subjected to mill abrasion after drying. The degree of disintegration varied from 17% to 45.4% for the first treatment and from 7.8% to 15.8% for the second. Disintegration did not alter total protein, ash or individual amino acid levels. When the yeast was added to the feed of chicks, the disintegrated yeast was found to improve protein digestibility by 2-3.9%, assimilation of feed energy by 0.6-2.0%, and weight of the chicks after 49 days by 5.6-10%, as compared to undisintegrated yeast. Feed expenditure per unit mass produced was reduced 0.87-5.5%. Chick viability was unaffected. The economic effect of using disintegrated yeast was calculated to be 31.4-63.0 rubles per 1000 chicks. References 3: Russian.

Adhesive Melts for Sanitary Hygienic Articles from Fluffed Cellulose

917M0042e Moscow GIDROLIZNAYA I
LESOKHIMICHESKAYA PROMYSHLENNOST
in Russian No 8, Nov-Dec 1990, p 14

[Article by G. V. Bronnikova, N. N. Salomatina, R. I. Kireyeva, and T. P. Iordan, Central Scientific and Planning Institute of the Wood Chemistry Industry]

UDC 630*86.002.6:676.014.44

[Abstract] The Central Scientific and Planning Institute of the Wood Chemistry Industry has developed an adhesive, designated LKh-4, intended to replace the German Lunatak D-50 adhesive previously used to produce sanitary articles from fluffed cellulose. LKh-4 has a softening temperature of 81-90, slightly lower than Lunatak D-50 (100-102). Its viscosity at 190 is 12-16 Pa sec; its melt fluidity index at 190 is 10 g/10 min. LKh-4 has a flash point of 254, a flammability temperature of 279, and an autoignition point of 455, indicating that it is not hazardous. Its density is 0.959 g/cm³, its specific heat capacity 2.57 kJ/kg K, and its specific heat conductivity 0.22 W/M K. LKh-4 was successfully used in the preparation of disposable diapers. References 2: Russian.

Transformation of Mechanism of Electron Conductivity With Increase of Heteropolarity of Melts

917M0043A Kiev UKRAINSKIY KHIMICHESKIY ZHURNAL in Russian Vol 56, No 10, Oct 1990 pp 1031-1034

[Article by V. F. Zinchenko and V. I. Lysin; Kiev Highway Institute]

UDC 541.133+541.135.6:546.683.1:546.23-546.22/546.15-546.13

[Abstract] A study of transformation of the nature of conductivity and electrochemical properties of a poly-functional conductor under the effect of a heteropolar additive in the entire interval of compositions permitted postulation of the problem concerning establishment of a quantitative dependence between conductivity parameters and change of heteropolarity of the medium as a function of the composition used melts of $Tl_2S(Se)-TlI$, $Tl_2S-TiCl$ and $Ag_2S-AgCl$ systems. Change of the nature of electron conductivity from a band mechanism to jump mechanism occurred in proportion to the heteropolarity of the medium. The location of electrons and the transition from a band to a jump mechanism was highly pronounced only at a definite heteropolarity of the medium. These critical values of enthalpies of formation of melts characterizing their heteropolarity at which the transition from the band to the jump mechanism of electron conductivity occurs were assessed. Figure 1; references 5: 4 Russian; 1 Western.

Electrochemical Reduction of Ruthenium in Solutions Containing Sulfamates

917M0043B Kiev UKRAINSKIY KHIMICHESKIY ZHURNAL in Russian Vol 56, No 10, Oct 1990 pp 1054-1057

[Article by L. B. Kharkova, N. Ye. Nechayeva, G. N. Sosnovskaya et al.; Institute of General and Inorganic Chemistry; UkSSR Academy of Sciences; Kiev]

UDC 541.135.5

[Abstract] An explanation of some kinetic regularities during electrochemical reduction of ruthenium on the basis of the effect of different factors on proceeding cathodic processes showed that the distinguishing feature of electrolytes containing a complex of ruthenium and ammonium sulfamate is the formation in them of sulfamate-containing complexes of metals, discharging at the cathode, that is, the electrode reaction precedes the chemical reaction. Reduction of the ruthenium to a metal by a catalytic mechanism paralleled the electrochemical process. This was shown by the dependence of the coefficient of slope of the Tafelvskiy lines and the

electrode potential on the pH of the electrolyte. Figure 1; references 11: 7 Russian; 4 Western.

Effect of Fluidized Bed of Glass Particles on Cathodic Processes During Electroreduction of Cadmium Ions

917M0043C Kiev UKRAINSKIY KHIMICHESKIY ZHURNAL in Russian Vol 56, No 10, Oct 1990 pp 1057-1062

[Article by N. A. Shvab, N. V. Stefanyak, Ye. I. Kondruk et al.; Institute of General and Inorganic Chemistry; UkSSR Academy of Sciences; Kiev]

UDC 541.135.5:621.357.7

[Abstract] An attempt to show the principles of effect of hydrodynamic and mechanical factors on the intensity of electrolysis in a fluidized bed of inert glass particles, the depth of cadmium extraction from a solution of different composition and the quality of the metal obtained was performed on the example of extraction of cadmium from acidic sulfate electrolytes and their rinse waters. The mechanism of mass transport during collisions of the particles with the cathode surface was disclosed. Electrolysis in a fluidized bed of glass particles proved to be effective in extracting cadmium and other non-ferrous metals from spent electrolytes and rinse waters of galvanic productions. Figures 5; references 11: 7 Russian; 4 Western.

Electrocatalytic Activity of Ternary Dispersed Nickel-Titanium-Copper Alloys

917M0043D Kiev UKRAINSKIY KHIMICHESKIY ZHURNAL in Russian Vol 56, No 10, Oct 1990 pp 1068-1070

[Article by A. N. Sofronkov, E. N. Perviy and A. D. Andreyanov; Odessa Technological Institute of the Food Industry]

UDC 541.136

[Abstract] A study of non-pyrophore dispersed systems of nickel-titanium-copper with 6 percent titanium content produced on the basis of a nickel-aluminum alloy used thermogravimetric analysis, electron paramagnetic resonance analysis and the method of suspension oxygen half-cell to study the alloys. Data concerning the electro-magnetic spectra resonance spectra and the electrocatalytic activity of the alloys showed the presence of a peak as the function of the copper content in it. The maximum electrocatalytic activity occurred in alloys with a copper content of 20 percent. These data were explained by use of free energies of formation of nickel, titanium and copper oxides and by the d-metallic content of the bond in the alloys according to Poling. An alloy of this composition had the greatest number of unpaired electrons. References 6 (Russian).

Chernobylite: Technogenic Mineral

917M0046A Moscow KHIMIYA I ZHIZN in Russian
No 11, Nov 90 p 12

[Article by Valeriy Soyfer]

[Text] *The composition of crystals observed in lava stacilites formed after the accident at the fourth generating unit of Chernobyl Nuclear Electric Power Plant is determined. This crystal silicate of zirconium and uranium has been named chernobylite.*

A year ago, in honor of the 100th birthday of radio chemist Academician V.G. Khlopin, Leningrad Radium Institute established honorary medals and diplomas for outstanding work in the field of radio chemistry. The first holders of these medals are members of a Comprehensive Expedition of Kurchatov Nuclear Power Institute: A.A. Borovoy, V.I. Markushev and K.P. Checherov, who studied the state of nuclear fuel following the accident at Chernobyl Nuclear Electric Power Plant.

Naturally, fuel was not the only thing that had to be studied. As reported by the large-circulation Kurchatov newsletter SOVETSKIY FIZIK (29 Jun 90), expedition members also investigated fragments of graphite brickwork thrown out by the explosion, highly radioactive dust, and a sintered mass formed in some rooms of the Chernobyl Plant that has been called lava by analogy with the similar product of volcanic action. Only in contrast to natural lava, this material was heavily enriched with uranium and other radioactive elements.

This lava was not encountered only yesterday. Back in 1986, soon after the accident, a gigantic coagulated black glob, several cubic meters in size, was discovered in one of the rooms of the power plant. Some wit called it the elephant's foot, not realizing that subsequently three more such "feet" would be found beneath the tomb (physicists prefer the term "concealment")...

It was not easy to get a sample: the radioactive background near the first foot was 8000 roentgens per hour. Therefore, pieces for analysis were chipped off by shots. Analysis showed that the foot is roughly 70 percent silicon dioxide, there are metallic inclusions and other impurities, and nuclear fuel makes up from 2 to 10 percent of the mass of the glob (from 1 to 20 percent in the other feet). Various techniques were used for analysis: from the now conventional spectroscopy to electron microscopy and x-ray spectral microprobing. As it turned out, the black lava differs somewhat in composition from a chocolate brown lava discovered later.

Detailed investigation of the technogenic lava is of interest primarily from the standpoint of radiation safety. It is important to predict its future behavior. Over the years, lava loses strength, and is converted to dust as it gradually breaks up, and we hardly need to explain how dangerous radioactive dust can be. Moreover, the lava was formed directly in the accident, and it carries

information about what happened, especially about the temperatures developed in the epicenter of disaster during those April days and nights. The melting point of lava is 1200°C. But the metallic inclusions, their composition and state, indicate that the temperature rose beyond 1500°C.

Crystal formations were found in these same samples that were identified as a silicate of zirconium and uranium. It is these that were named chernobylite. Classical mineralogy had not known crystals of this kind.

Topic of the Day: Did Komsomolets Go Down by Accident?

917M0046B Moscow KHIMIYA I ZHIZN in Russian
No 11, Nov 90 pp 35-38

[Article by V.N. Mineyev, doctor of physical and mathematical sciences, V.V. Korenkov, candidate of technical sciences, and Yu.N. Tyunyayev, candidate of physical and mathematical sciences]

[Text] On that fatal trip of 7 April 1989, fire broke out in the stern compartment of the Komsomolets. Almost instantaneously for such a volume, within seven-19 minutes, four more compartments caught fire. The submarine surfaced five minutes later. The nuclear reactor was shut down. The fire was extinguished in all but two compartments, and it might have been hoped that the submarine would be saved, but within four hours after the fire broke out, the stern of the submarine went down, and a half hour later there were explosions in the compartments. Six hours and eight minutes after the fire had started, the submarine rose up like the bobber on a fishing line, and sank. The escape chamber slipped off, like a rider from a horse, and rose to the top, only to go down again to a depth of 1600 meters beneath the Norwegian Sea.

Is the "Fate of the Tester" to Blame?

Fire is a dreaded enemy of submarines. Fires make up 20-30 percent of all submarine accidents. Their causes are fairly obvious: electrical short circuits, spontaneous combustion of fuel, oil and hydraulic fluid, and explosions of the vapor of these materials. Fighting fires on nuclear submarines is much more difficult than on land or on surface vessels. A sub was once even temporarily flooded to put out a fire, but none of the flames were drowned. Data about accidents of submarines in the Russian fleet (prior to 1917) and of the fleets of capitalist nations (up through 1988) can be found in the book "Katastrofy v morskikh glubinakh" [Disasters Under the Sea] by A.A. Narusbayev (Leningrad, "Sudostroyeniye," 1989). Since there are no data of this kind on Soviet submarines, one gets the impression that they are accident-free.

We have recently learned that Soviet submarines have, nonetheless, had such accidents: in June 1984 and in October 1986. But according to reports of the Western press, a total of five Soviet nuclear submarines has sunk:

in 1968, 1970, 1983, 1986 and 1989. And from June through December, there were three accidents, not counting the sinking of the Komsomolets.

We do not know what steps were taken after each accident.

But it avails nothing that N. Cherkashin (PRAVDA, 12 May 1989) wrote that "the sinking of the Komsomolets cannot in any event be put on a par with Chernobyl, the explosion at Arzamas, or the tragic Nakhimov collision. The road to death then was opened by criminal negligence. Here it was the tester's fate."

We content that, just as at Chernobyl, the Komsomolets disaster was sealed in its design. But neither the crew nor Naval Command had any inkling of this, and had faith in the "unsinkability" of the Komsomolets up to the last minute. If they had known about the real vulnerability of the sub, people might have been saved.

In the full official name "experimental nuclear torpedo submarine Komsomolets," the word "experimental" accurately presaged tragedy. For a long time, our ministries have been operating like a Canadian hockey team: the main thing is to get the puck into the opponent's penalty area, and then somehow make a goal. This is apparently how the Ministry of the Shipbuilding Industry figured that the main thing was to get the submarine off the ways, and then the seamen would somehow make up a list of the things that went wrong, and the Ministry would take them into account (in part) in the next generation of nuclear submarines.

Let us, gentle reader, do some simple thought experiments to answer the question of what could have caught fire and exploded aboard the Komsomolets, and how water got into the submarine.

For if we, not being shipbuilders, can manage to answer such questions, then surely specialists were obliged to foresee and prevent even the possibility of these hazards. Wouldn't you say so?

What Could Have Burned Aboard the Komsomolets?

The fire started from a flash in the electrical system. After some time, the walls of pipes got hot and burst. Fuel, air, probably oxygen as well spewed from the broken lines and poured oil onto the fire. Within a half hour after the fire had started, at a temperature of 800-1000°C, the hydrocarbon fuel ignited.

Other materials that could have burned were lubricants and hydraulic fluids gushing under pressure from broken lines, the detonators of torpedo warheads, and the powder in the gas generators for blowing out the ballast tanks. The latter do not need oxygen, as they already contain it.

Even the outer rubber cover of the submarine swelled up and slid off like a "stocking." It would suffice to heat the outside of the hull to 200-400°C to get such an effect. Knowing this, we calculated the heat balance of the

system comprising combustion products, titanium hull and water, and determined the temperature of the inner surface of the hull. It was 300°C, and hence the power of the heat released by the fire approached 30 kW/m². If the area of the surface of the submarine in the region of intense fire is roughly 600 m², then 1.8 metric tons of hydrocarbon fuel pouring from the lines would burn in an hour.

Quite inopportunistly, the materials from which the submarine was made were also combustible: organic (plastic, rubber, paint, lacquer) and inorganic (aluminum and titanium alloys).

But neither organics nor metals will burn without oxygen.

How much oxygen might there be on a submarine? That depends on the amount of air in the life support systems for the crew and for blowing out ballast. By our estimates, at least 20 metric tons. This would suffice to burn four times the amount of hydrocarbon fuel, and two metric tons of aluminum and titanium alloys as well in four hours time. Even the powder can be ignored in the general heat balance. It is perhaps important that the temperature of the products of its combustion (2000-3000°C) is twice as high as for hydrocarbons. If such hot gases should begin licking the titanium hull, it would incandesce (up to 900-1000°C), and not only burn, but would interact with the nitrogen of the air, and even with iron scale. Recall that all these reactions take place with intense liberation of heat.

What Might Have Exploded Aboard the Komsomolets?

Explosions were provoked by the thermal energy of the fire. There were several hundred kilograms of powder in the gas generators alone.

Fuel-air mixtures could also have exploded. To make matters worse, strong heating intensely dissociates the chlorate candles used for oxygen regeneration. The candles were stored in sealed tins, making a kind of bomb (under conditions of the fire).

Only the torpedoes escaped. They were located in parts of the submarine where the fire did not rage, or was quenched. There is no need to blame them.

How Did Water Get Into the Komsomolets?

The intense fire in the submarine went on burning for four hours, i.e. until the occurrence of trim by the stern (longitudinal inclination of the ship). It then became clear that water was coming aboard. According to our calculations, the water was being taken on through holes (about 10 cm) burned in the hull where lines had passed through it. On conventional submarines, the correction of trim is a comparatively short and easy job. But the trim of the Komsomolets was noticeable even from an airplane. It increased for an hour and a half (!) until the first explosions were heard. The seamen, as before, believed that the submarine could yet be saved, and therefore did not get ready their survival gear.

However, explosion of the gas generators, which were located too close to the hull, breached it because the titanium had been weakened by heat and corrosion. The water gushing through the breach flooded the stern, and the bow was clear of the water at an angle of 70 degrees to the surface.

A large trim is like death to a submarine afloat without a kingston sea valve. Alas, there were no kingstons (hatches in the strong hull) on the Komsomolets, and this is contrary to the behests of Vice Admiral S.O. Makarov about unsinkability and viability of ships. If there had been kingstons, admitting sea water through them would have immediately put out the fire, and the trim would have been corrected by counterflooding (within an hour and a half beyond all doubt). But this sub was "experimental," and the designers did not leave the crew this option.

This is a good place to recall that S.O. Makarov had suggested the method of counterflooding for surface vessels as far back as in 1870. And since 1903-1905, the method has been mandatory for surface vessels of the Russian Navy. Academician A.N. Krylov and other shipbuilders have used it for submarines as well. To quickly correct the dangerous inclination of a submarine, calculations are done beforehand and summarized in a so-called table of surface unsinkability, and then transferred to the submarine. We wonder if such tables were carried aboard the Komsomolets.

Who Forged Poseidon's Trident?

And so, we have been convinced that by incorporating a host of blunders into their plan, the ship designers were planning a disaster without wishing to. And which of them asked whether even in the name "Komsomolets" there were not what would seem to be obvious words: "reliable," "unsinkable," "secure." Only "experimental." And new fundamental questions come up.

1. Who did not know that liquid fuel, and fluids in the lubrication and hydraulics system will form fuel-air mixtures that not only burn, but explode as well? Why did the lubrication and hydraulics systems, the arteries that drive the muscles of the submarine, become delayed action incendiary mines on the Komsomolets? Was there any structural protection?
2. Why weren't the powder gas generators protected from the fire?
3. Why did the electric wiring on the submarine burn, and why did the consoles and panels explode?
4. Why was it that the fire extinguishing system on the Komsomolets could be turned on only from the main command post? Why was it that mechanisms working not only to support the fire, but to intensify it were not disconnected in places?
5. How could the Komsomolets have been without kingstons?

If we compare a nuclear submarine with a trident, the weapon of Poseidon, god of the underwater kingdom, then the Ministry of the Shipbuilding Industry forged a trident that was lethal to the holder, naval seamen.

Is the Sunken Komsomolets a Hazard?

Newspapers reported details of the sinking of the nuclear submarine Komsomolets in the spring of 1989. And they almost simultaneously carried the news that a hydrogen bomb lost by the United States on the coast of Japan in 1965 had "sprung a leak." After a little more than two decades, the shielding armor of the warhead covering the plutonium was starting to leak. According to calculations by Japanese specialists, the U.S. plutonium is moving toward Japan at the velocity of the deepwater current (4 cm/s).

During the years of stagnation, we have all become accustomed to reading between the lines, and therefore we have easily interpreted these articles in PRAVDA and IZVESTIYA. Apparently, the newspapers have been calming their readers: we are not the only ones losing nuclear weapons. D.T. Yazov, USSR Minister of Defense, then declared: "We know beyond all doubt that the nuclear reactor (the Komsomolets—ed.) is dead. In the opinion of competent services, radioactive environmental impact is ruled out." Things have turned out so that although both "we" and "they" have sunken nuclear devices, ours is better, stronger, and not producing radioactive contamination. So that's how things stand.

Only why didn't the minister mention the two nuclear warheads on the sunken sub?

Let us take a crack at disagreeing with the "competent services." Radioactive contamination of water by wastes from the rusted nuclear reactor and from the nuclear warheads is inevitable, as operation of the chemical and physical laws of corrosion, diffusion and nuclear decay is inevitable. And there are corroborations for this. Radioactivity has been detected in the vicinity where the U.S. nuclear submarines Thresher and Scorpion went down. It cannot be ruled out that the nuclear reactors have "sprung a leak": after all, it has been 22-27 years since the submarines sank.

After such information, it only remains to draw the unhappy conclusion: the Komsomolets is a radiation hazard, and we have no more than 22 years to eliminate this evil. And the danger and complexity of raising the submarine will increase with every passing year.

The Ministry of Defense has shot the routine puck... but into its home zone, if not into its home goal, because the Komsomolets went down off the coast of Norway on the path of the warm Gulf Stream. Moving water accelerates corrosion, and hence dissolution of the reactor housing, and will irreversibly deliver what is inside to our own shores. So that apparently even before the year 2012, our children and grandchildren will get their "inheritance." The submarine has to be raised.

Radiation safety would have been less expensive for us if we had had the foresight to enclose the nuclear reactor and torpedo warheads in containers rigged for extraction from a sunken ship (remember how the hero of V. Hugo's novel "Toilers of the Sea" saws a hole through the bottom of the steamship, and lowers the engine for his boat through the hole?). Would it be so hard to make a hatch in the nuclear submarine, and through it pull out the ship's reactor prepackaged in a hermetically sealed "egg" made of concrete reinforced with glass and steel?

The Minister of Shipbuilders Renders an Account

A member of the governmental commission to investigate the causes and circumstances of the sinking of the Komsomolets, USSR Minister of the Shipbuilding Industry I.V. Koksanov on 13 May 1990, in answering questions of an IZVETSIYA correspondent, reported that the commission had basically completed its work. In particular, it has published an order which, as the minister reports "bears my signature and that of Marshal D. Yazov, USSR Minister of Defense." It would be naive to expect the individual signatures of any responsible persons who were a party to this affair. As of 1 July 1990 we could bring action only against a single director, and therefore the important decisions of interested parties were taken collectively. Such is social insurance.

For I.V. Koksanov, it was only following the work of this commission that it became clear that "a large amount of combustible material is used on a submarine, in the structure proper, in finishing, and in paint. Here, to be sure, there were no departures from rules and regulations. Everything in accordance with Industry Standards and Soviet State-Wide Standards. Apparently we should think about changing them." We do not doubt that everything was legal and substantiated by documents. But the culprit was not simply Gosstandart, as the minister would have us believe, but his entire agency that worked out the Industry Standards and Soviet State-Wide Standards. Not one of them would use a frying pan or an ashtray made of gunpowder or plastic, but they had mind enough to load 69 people onto such a "frying pan." You don't have to be a chemist to figure out what it would be like for people in a room made of combustible materials with no place to go. Apparently none of those who wrote, read and approved of these papers ever gave a thought to the possible consequences of fires on nuclear submarines with nuclear armament.

It might seem to some that we are misusing quotations. But they expose the incompetence of the minister to such an extent that paraphrasing would probably make us liable to slander. So let him convict himself out of his own mouth.

The minister reports that "a joint plan has been approved for immediate steps to improve the fire safety and reliability of equipment. Preliminary work is now in progress. The work is very serious and responsible. For example, there are proposals to place sensors on the vessel to give guaranteed indication of a fire. Research is

being done on the optimum placement of these devices." Only one conclusion suggests itself: the minister does not know that design of an automated fire extinguishing system should start from this research. The Ministry of the Shipbuilding Industry has forgotten that a system for fire detection in different areas of submarines was demonstrated by foreign companies at the "Firefighting Equipment-79" International Exhibition in Moscow ten years before the disaster.

Boats Afraid to Go to Sea

Minister I.V. Koksanov has publicized the unreliability of engineering in his own ministry. Indeed, our submarines spend more time dockside than out to sea. As reported by the Stockholm International Institute on Investigation of World Problems, on any given day more than 50 percent of U.S. nuclear submarines are at sea, and only 11-15 percent of Soviet submarines. Could this be our policy of peace? Or mere happenstance, something chronic? Neither. Our submarines are not only unreliable, but obsolescent. From foreign publications it is known that more than 40 percent of Soviet nuclear submarines have already seen more than 20 years of service, and should be written off.

The reader may legitimately ask whether we have taken account of foreign design experience, the lessons of U.S. nuclear submarine disasters? We have not. Unfortunately, we are learning only from our own bitter mistakes. And are we learning at all? You need proof? You've got it.

The circumstances of foreign nuclear submarine disasters have been analyzed in the press. Immediately after the Thresher and Scorpion went down, U.S. scientists and designers explained and publicized basic flaws in the Thresher design. To eliminate them, the United States halted the submarine construction program, modified it, and only then resumed construction.

By 1971, the United States had developed self-propelled deep-water vehicles for saving submarine crews, and all NATO submarines are equipped with standardized escape hatches for transfer to these vehicles. Elsewhere a high value is put on a man's life. For us it is "valueless" so far.

Let us recall that the Komsomolets was designed in the early seventies, and even then consideration could have been taken of some of the design errors that sank the Thresher. But they were not considered. The surface unsinkability of the Komsomolets was no better than that of the Thresher, the system for blowing down ballast was a fire hazard, the fire extinguishing system was ineffective and uncontrollable, and pipes were weak. The hull was the only thing that had been made stronger. But at what a cost! Doing away with kingstons! It was this omission that was lethal.

Why was foreign experience ignored? Who will answer?

The ministers of Soviet defense and the shipbuilding industry have once more successfully demonstrated the flawless operation of the system of total "collective security" of bureaucrats and disregard for human lives. The system is now operating reliably without a hitch for its users. By tradition, linemen and small fry are punished for the Chernobyl and Bashkir disasters, for the apocalyptic state of public health, culture and ecology in

our nation. Apparently right in front of us the task has actually been formulated and successfully solved of razing the world to the ground in an "experimental" nation individually grabbed by the throat.

It is finally time for our society to "turn green" from responsibility for the fate of our children and grandchildren...

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